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CONTENTS

	Page
National Parks in Britain	631
Radar, Beacons and Navigation by Radio. By Dr. R. L. Smith-Rose	633
Population Policy in Great Britain. By Prof. Walter Fitzgerald	635
Herbs and Drugs. By Dr. W. O. James	636
Development of Synthetic Rubber in the United States. By Dr. C. W. Long	637
Process Heating in Industry. By M. R. Gavin	637
Colour Vision	639
Marine Fisheries of Great Britain. By Michael Graham	641
Inbreeding and Hybrid Vigour in Crops and Livestock. By Prof. K. Mather	642
The World Federation of Scientific Workers. By J. G. Crowther	644
News and Views	645
Letters to the Editors :	
Multiplication of Bacteriophage.—Dr. Ralph W. G. Wyckoff	649
Ultra-Violet Microscopy of Living Malignant Cells.—Dr. R. J. Ludford, J. Smiles and F. V. Welch	650
Cytochemistry of the Gonadotropic Hormones.—Anthony G. Everson Pearse	651
Relative X-Ray Sensitivity of Metaphase and Interphase Chromosomes.—Dr. Arnold H. Sparrow	651
Production of *i*-Erythritol by *Aspergillus niger*.—John L. Yuill	652
Thixotropy, and the Mechanics of Burrowing in the Lugworm (*Arenicola marina* L.).—G. P. Wells	652
Some Geometrical Considerations Regarding Imbricate Æstivation.—Dr. K. J. Dormer	653
Initiation of Explosions by Grit Particles.—Dr. F. P. Bowden, F.R.S., and O. A. Gurton	654
Dielectric Properties of Mixed Barium and Strontium Titanates at 10,000 Mc./s.—Dr. J. G. Powles	655
Dielectric Behaviour of Methyl Palmitate : Evidence of Resonance Absorption.—J. S. Dryden and Prof. Willis Jackson	656
Velocity of Sound in Free Air.—J. M. A. Lenihan	656
Studies in the Synthesis and Isolation of Threonine.—Dr. D. F. Elliott	657
Conversion of DL-Serine into Inactive Cystine.—Dr. D. F. Elliott	658
Synthesis of Derivatives of N-Methyl-2-Pyridone from Nicotinic Acid and Nicotinamide.—Chr. Wiegand and W. I. M. Holman	659
Species Difference in the Biosynthesis of Vitamin C and Response to Diabetogenic Substances.—Prof. M. C. Nath, C. H. Chakraborty, V. G. Hatwalne and Miss Kusum S. Laul	660
Use of Certain Growth-Inhibitors as Tools in Metabolic Investigations.—R. J. Pennington	661
Retinene$_1$ and Indicator Yellow.—Alfred F. Bliss	661
Partition Chromatography on Starch of Ribonucleosides.—Peter Reichard	662
Eighteenth Session of the International Geological Congress	663
School of Pharmacy, University of London	663
British Empire Cancer Campaign. By Dr. D. A. G. Galton	664
An Electron Microscope Study of Cellulose in the Wall of *Valonia ventricosa*. By Dr. R. D. Preston, Dr. E. Nicolai, Dr. R. Reed and A. Millard	665
The Young Worker in Industry. By Sir Arthur Fleming, C.B.E.	667
Society for Applied Bacteriology	669
Free Energy of Protein Solutions	670

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NATIONAL PARKS IN BRITAIN

THE implications of the revolution in the British system of land tenure which occurred on July 1, 1948, when the Town and Country Planning Act, 1947, came into force, are even yet far from being generally appreciated, although the Act immediately affects millions of property owners. It represents, indeed, a great experiment in social control. Old individual liberties are put in trust for the common good; but few as yet understand the methods of community planning or the discipline which planning requires of them. Nor are the technical implications fully realized—the need for development planners of higher quality and better training, for a new tradition in which economics, sociology and geography are blended with the skill of the architect, the engineer and the surveyor into something at least approaching a science.

The success of the Act depends at all points on the readiness of local authorities to use in the public interest the opportunities it offers them. No longer need the fear of cost to themselves inhibit the use of their powers to prevent bad development. Only experience and the growth of the science of planning can ensure that those powers are used positively and constructively, not merely to prevent bad but also to encourage the best development. Moreover, there is real reason to fear that the Act does not put power in the hands of those best qualified to exercise it from a regional or national point of view. It seems that regional advisory committees are unlikely to maintain even their former persuasive influence, and that there is no intention of creating executive joint planning boards. Until the structure of local government has been organised on even bolder lines than those suggested by the Boundary Commission, the machinery for planning will scarcely match the power at its disposal.

There are two main reasons for uneasiness. The Minister of Town and Country Planning, Mr. Silkin, has always been reluctant to admit that there might be needs which the Act does not meet, and in a recent speech at Cambridge he misrepresented seriously the views of the national park movement in seeking to defend his resolve to reject even the compromise for a national park authority represented by the recommendation of the Hobhouse Report. While he refrained from making suitable provision for national park planning until it automatically became vested in the county councils, he now protests that it would be unreasonable to take away from them what they have so recently acquired.

It has long been plain that the county councils do not accept the essence of the national park thesis: Great Britain is a crowded island; but a few areas must be reserved in which the claims of natural beauty and its enjoyment shall stand supreme. The Southampton Borough Council's proposal to invade a public park in Southampton, against which hundreds of objections have been lodged, is only one recent example which demolishes Mr. Silkin's contention. Such examples could be multiplied indefinitely in London, Manchester and many other

places, where although some encroachments might be justified, most are due to the authorities taking the line of least resistance. The natural beauty of Britain cannot long survive such a process of attrition, and a great merit of the pamphlet "National Parks or 'Local Authority' Parks", just issued by the Friends of the Lake District, is that it displays clearly the picture of attrition in one particular area over the last twenty years. On any wide and general view, the Lake District has lost not a little which it can never regain, and has not had the treatment proper to a kind of national property. During the last generation, the best areas of our landscape have suffered steady attrition, and both the pace and the field of injury are increasing.

Even if the local authorities could be expected and trusted to take a national view, it is also clear that, as 'local' authorities, they would be unable to avert the second main danger—that of encroachment from the Departments of State, and especially the Service Departments. Strong opposition has been manifest to the Army's proposed requisition of 1,870 acres of Cannock Chase; opposition which was supported indeed by the Staffordshire Cou ty Council. Already the Armed Forces have demanded a gun site near Holy Island, a bombing range at Selsey Bill and battle-training areas across Norfolk and Wiltshire villages, and cynically disregard promises or pledges given during the War. Retention of the areas held at Stamford and at Purbeck for battle-training areas is leading to widespread distrust of the Government's sincerity or even good faith.

Nor is it only the Service Departments that are responsible. Water supply and catchment area authorities, the Ministry of Transport, and the Forestry Commission all sponsor demands which despoil the countryside, and often encroach on areas recommended for preservation as national parks or Nature reserves. Seldom is there any indication of an attempt to consider alte .native means of meeting a sectional or local need without detriment to the interests of the nation as a whole. The report of the Gathering Grounds Sub-Committee of the Central Advisory Water Committee on "Public Access to Gathering Grounds and Afforestation and Agriculture on Gathering Grounds" (London: H.M. Stationery Office, 1948. 9d. net) constitutes an honourable exception, which deserves special mention. Under the chairmanship of Mr. A. P. Heneage, this committee has brought an admirable sense of national interest to bear on a special problem, and declined to allow unsupported sectional prejudice to prevail. Its recommendations relate to the conduct of the gathering grounds of upland reservoirs where adequate purification processes exist. Arrangements should be made, it urges, to dispose of the sewerage from human habitations, whether permanent or temporary, in a manner that will entirely preclude the possibility of its getting into the reservoirs. Farmyard manure should be prevented from draining directly into feeder streams or reaching the reservoir, and the public should be generally excluded from the banks of reservoirs and no bathing allowed. Fishing and boating may sometimes be allowed at the discretion of the authority, but only under rigorous control. Feeder streams may sometimes require like restrictions; but subject to these safeguards, the land should be put to the utmost agricultural use, and land which is incapable of agricultural use should, if possible, be afforested, but with due regard to amenity and the requirements of adjacent agriculture. Subject to these recommendations, the committee sees no reason for excluding the public from gathering grounds as such. Indeed, the report is a well-deserved rebuke to certain authorities which have relied on such negative restriction rather than on the positive safeguards which are still required even if the public are excluded. Incidentally, the committee was satisfied that many gathering grounds could be put to much greater agricultural production than at present.

Despite the admirable spirit of this report, there can be little optimism at present that due effect will be given to its recommendations in the absence of adequate authority. Provision of the essential requirements for a system of national parks and for co-ordinating at the highest level the competing departmental requirements for land would, of course, meet this requirement incidentally; but even the requirements urged by the Friends of the Lake District will scarcely avail while the Government refuses to establish a more effective authority than an inter-departmental committee, and continues to allow demands for land to be presented piecemeal and without regard either to available resources or competitive national needs.

Whether or not it was the intention that the Minister of Town and Country Planning should act as the co-ordinator in this matter, events have demonstrated that he possesses neither the stature nor the vision to exercise such authority. Meanwhile, it is clear, in view of the probability that the Government's programme for the forthcoming session will include a Bill to secure freer public access to mountains and moorland, to control holiday facilities in national park areas and to conserve wild life, that the essential requirements for an effective system of control should be understood.

The two essential principles outlined by the Friends of the Lake District and in the earlier reports are essentially the same both for national parks and Nature reserves, differing only in the details of application for the two purposes. The first requirement is to concentrate in a specialized body, a national parks commission, the duty of elaborating and maintaining a special code for the parks and Nature reserves. This would provide the means for dealing directly and on more or less equal terms with Government departments and public corporations, and it would also avoid the anomalies which will arise if the control is left with the county councils, as Mr. Silkin suggests, a scheme under which the Lake District would be administered by three, North Wales by four, and the Peak district by four or five separate bodies.

Secondly, on the plane of local planning, the national interest must be introduced by establishing a special park or Nature reserve committee. This would provide a unified planning authority for

dealing with each park as a single whole, assessing the national need against local needs. Mr. Silkin himself and other participants in the recent controversy have misrepresented this function, in spite of overwhelming evidence that the local authorities cannot be relied upon to put national interests first, and indeed should not in fairness be expected to do so. In answering that criticism, moreover, the Friends of the Lake District in the pamphlet referred to also dispose of the suggestion that the parks committees, constituted as suggested in the Hobhouse Report, are undemocratic; and they quote pertinent instances in regard to roads, electricity and the National Assistance Board in support of the reasonableness of the Hobhouse compromise. Nor can it well be argued that from the purely administrative point of view the proposed system for national parks cannot be worked side by side with that laid down for other purposes in the Town and Country Planning Act of 1947.

What must be clearly understood at the present moment is that at no level is the necessary administrative machinery established or retained under the new Planning Act to enable a consistent planning policy to be applied either to national parks in general or throughout any one of the principal national park areas designated in the National Parks Committee's reports, or those of the Wild Life Conservation Committee. Even if the local authorities were really interested in national parks and there were not the difficulty of particular parks being the concern of three, four, or five county authorities with widely varying outlooks, populations and rateable values, the administration of such areas puts an unreasonable strain on the loyalties of the councils. County parks they might provide, but not national parks; and there would be no assurance that these parks would be secure against the intrusion of sectional interests, let alone of Departments of State.

It cannot be too strongly emphasized that in little more than a year after the publication of the Hobhouse Report, not only has no action been taken to implement its proposals, but also in the interval further irreparable damage has been done to our dwindling reserves of natural beauty, amenity, flora and fauna; further, that the conception and prospect of both national parks and Nature reserves have become more seriously endangered than at any time since Mr. John Dower was asked to prepare his report, and that by Government action—and inaction. It is equally true that the new Planning Act, the Requisitioned Land and War Works Act and the White Paper on the Needs of the Armed Forces for Land for Training and Other Purposes, have done more on the whole to alarm than to reassure public opinion, and have to some extent tended to dissipate that considerable measure of goodwill on which the prospects of a general agreement and an effective safeguarding of Britain's heritage of natural beauty and wild life must be based. In this respect the Government seems to be bent on evading the responsibilities conferred on it, with widespread approval, by recent legislation.

RADAR, BEACONS AND NAVIGATION BY RADIO

(1) Radar Aids to Navigation

Edited by Assoc. Prof. John S. Hall. (Massachusetts Institute of Technology, Radiation Laboratory Series, Vol. 2.) Pp. xiii+389. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 30*s*.

(2) Radar Beacons

Edited by Prof. Arthur Roberts. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 3.) Pp. xx+489. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36*s*.

(3) LORAN: Long Range Navigation

Edited by J. A. Pierce, A. A. McKenzie and R. H. Woodward. (Massachusetts Institute of Technology: Radiation Laboratory Series, Vol. 4.) Pp. xiv + 476. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

ALL those who have been in any way connected with the vast developments in radio and radar techniques during the past decade will be familiar with the extensive contributions made during the war years by the staff of the Radiation Laboratory of the Massachusetts Institute of Technology. Much of the basic scientific and engineering knowledge which resulted from these contributions has been collected together by an editorial staff working under the auspices of the United States National Defense Research Committee and is now being published in a series of volumes which has become familiarly known in the radio world as the 'five-foot shelf'. The general design and scope of this publication, and details of the introductory volume to the series, have already been described in *Nature* (June 5, p. 867). The present review is concerned with Vols. 2, 3 and 4 of the series, which together add another three inches to the shelf.

(1) As its name implies, the volume edited by Dr. John S. Hall describes the advantages and limitations of radar technique when applied to the problems of navigation and pilotage, whether the equipment is airborne, shipborne or ground-based. The book is divided into four parts, the first of which is of an introductory nature. An opening chapter on the principles of radar serves to make the book self-contained without reference to the first volume of the series. The second chapter has also been included to give the reader a more comprehensive picture of available techniques, and deals with what are termed non-radar navigational aids. These include various techniques for determining the direction of a sending station, and also the hyperbolic systems that measure range differences such as Decca, Gee and Loran: the latter is dealt with in considerable detail in volume 4 of this series (see below).

The real substance of the present volume begins in Part 2, entitled "Airborne Radar". The four chapters in this section are devoted almost exclusively to the characteristics, design and performance of the type of centimetre-wave radar equipment developed for precision blind-bombing purposes during the War, and now being applied to the navigation of civil aircraft. A series of excellent photographs illustrates the detailed display that can be obtained in this technique with systems of high resolving power used on a wave-length of 1·25 cm. Unfortunately, it has been found in practice that the presence of a water-vapour absorption band precludes the use of

this wave-length except in very clear air and at short ranges; and with the longer wave of 3 cm. now being generally adopted, the features presented to the operator or pilot are less distinct, although they still retain considerable navigational value.

Part 3 deals with centimetre-wave radar equipment used on the ground, particularly for the guidance and control of aircraft traffic at and between airports. In this case the restriction on the size of the antenna system which may be used is not so severe as with mobile equipment, and high resolution can be obtained with the longer waves, up to 10 cm., which have been used so successfully for aerodrome approach and landing purposes. Chapter 8 is devoted to the important subject of air navigation and traffic control, which will present problems of increasing importance, particularly in bad weather conditions, as the use of civil aircraft grows in the next decade or so in all parts of the world.

The last two chapters in the book comprise its fourth part, entitled "Shipborne Radar". Much of the material here presented will be more familiar to those who have followed the recent application in Great Britain of centimetre-wave radar to mercantile marine navigation. But it is interesting to have this description of the earlier work done in the United States, upon which are based the corresponding developments there.

Altogether the preparation of this volume by the thirty-three authors responsible for it has been well worth while; but it is perhaps a pity that it was decided not to include a glossary, which would have made things a little easier for the reader who is not very familiar with radar technique and language.

(2) The next volume, by Prof. Arthur Roberts, can be regarded as in a sense complementary to the one referred to above. For a radar beacon is a device which is normally quiescent but which, when 'interrogated' by a suitable pulse-modulated signal from a radar sender, 'responds' by emitting another signal much stronger than that which would have been obtained by reflexion as in simple radar. It is learnt in the first chapter that the radar beacon was invented in 1939 by a group of British workers at the Bawdsey Research Station of the Air Ministry, in response to a need for distinguishing between enemy and friendly aircraft when using radar detection methods. From this simple beginning, the radar beacon was developed during the War for a variety of applications, of a navigational, offensive and defensive nature. This book describes the work on beacons which was carried out in the Radiation Laboratory, where a separate division was organised for the purpose in 1943.

For the general reader the first part of the book, entitled "Basic Considerations", is probably the most interesting. In the course of six chapters, prepared chiefly by the editor, a most useful account is given of the technical possibilities of beacons for ship, aircraft or ground-station use. The methods of interrogation and reply coding to discover and identify beacons, the synchronization of signals for the determination of their range, and the effects of propagation conditions, choice of frequency and interfering signals are all described in a lucid manner. The sixth chapter deals with traffic and engineering considerations, and discusses such matters as the saturation of the interrogation link and the permissible density of beacons; subjects which are likely to be of great importance in the application of beacon technique to civil air navigation.

Part 2, which comprises about half the book, describes in some detail the component parts of a beacon and their assembly into the complete equipment. The experience and technical progress here recorded should prove invaluable to the engineer responsible for designing a radar beacon system for any purpose. In a similar manner, Part 3 supplies the corresponding information required for the design and development of the radar interrogation system with which the beacons are to co-operate in providing the desired information as to range and azimuth. Typical beacon systems for air-to-ground and ship-to-shore use are described in this part of the book; and brief reference is made to the Shoran precision beacon system, which, although not developed at Massachusetts, is referred to as the most accurate radar system for aircraft navigation to horizon ranges that had been developed up to 1945. In this method the navigator in the aircraft determines his position accurately by measuring range only to each of two fixed beacons at known locations on the ground.

The final chapter, comprising Part 4 of the book, gives a useful account of experience in the choice of sites for beacons on the ground and in ships and aircraft, and in the installation, operation and maintenance of beacons in such situations. In view of the large number of special terms and code letters which have arisen during the development of radar-beacon technique, the glossary given at the end of the book will be particularly welcomed by the student and reader who are not too familiar with this subject.

(3) The fourth volume of the Radiation Laboratory Series describes a long-range system of navigation, which depends upon the transmission and reception of pulse-modulated radio signals, but which differs from radar technique in using much longer waves and in not involving reflexion from a target. The Loran system, developed at the Radiation Laboratory during the War, is a hyperbolic navigational aid in which the position of a receiver is determined by the simultaneous observation of distances from two pulsed sending stations in known positions on shore. It has many points in common with the Gee system developed somewhat earlier in Great Britain for the navigation of aircraft out to horizon range and somewhat beyond; but by the use of much greater wave-lengths, or lower frequencies, Loran provided a means whereby ships, as well as aircraft, could be navigated to distances of from 500 to 1,500 miles using both ground and ionosphere-reflected waves. The progress made in the exploitation of the Loran system in America was very rapid, and at the end of the War some seventy transmitting stations were in operation in various parts of the world, and details of these are given in an appendix to the book.

The purposes of the present volume are to describe, first, the principles of the Loran and its possibilities as a means of navigation over considerable distances, and secondly, to record in some detail the position which the development of the necessary equipment had reached at the close of hostilities. After an introduction and a brief account of the history of the subject, the third chapter describes the principles of Loran, based on the measurement of the relative times of arrival of received pulses emitted alternately, with a known delay interval, from two fixed sending stations. Both stations are equipped with crystal oscillators which define the pulse recurrence-rate, but one of the pair acts as the master and is used to

regulate the oscillator of the second or slave station. Assuming a knowledge of the speed of the radio waves and of the paths along which they travel from sending to receiving stations, then the relative distances of the two fixed stations can be determined to a very high accuracy from the time observations made at the receiver. The carrier frequencies chiefly used in the practical development of the system were about 2 Mc./s. for the standard Loran and 180 kc./s. for low-frequency Loran. In Chapter 5, the propagation of waves at these frequencies is discussed, first with the view of demonstrating that for ground-wave transmission the maximum useful range is about 700 miles at the higher of the above frequencies and about twice this distance at the lower frequency. Consideration is then given to the propagation of these radio waves through the ionosphere and the consequent effect of diurnal and other variations on the received observations. Much empirical information has been collected together in this chapter, and this will probably repay further study in connexion with the future application of this system of navigation. Chapter 6 deals with methods of computing the tables and charts which form such an essential part of a practical system of navigation, where the operation of converting the radio observation into a charted position must be accomplished as quickly and as simply as possible. It is stated in the preface that, up to the end of the War, the U.S. Hydrographic Office had prepared and issued two and a quarter million of the special hyperbolic charts required by the agencies operating the various chains of Loran stations.

The second half of the book, comprising the last six chapters, deals in some detail with the various items of equipment and technique forming the complete system. These chapters, like the remainder of the book, are profusely illustrated with diagrams and photographs, and give clear descriptions of the transmitting and receiving equipment, the antenna systems, and particularly of the special techniques and apparatus used for regulating and timing the pulse-modulated waves. Appendixes devote further space to discussion of the geometry of the Loran system and to the determination of errors in the positions of the transmitting stations. A classified bibliography occupying twelve pages is given at the end of the book: a very small proportion of the references are to normal technical publications, the great majority being to the special reports and instruction manuals which were produced during the war years by those responsible for the development of the various phases of this new and successful means of long-range navigation.

Altogether, these three volumes form a noteworthy and most welcome addition to radio literature and will ensure that much of the specialized knowledge and experience gained at the Massachusetts Institute of Technology during the war years is readily available to future workers in this subject. The preface to two of the books and of others in the same series concludes with this sentence: "The publishers have agreed that ten years after the date on which each volume of this series is issued, the copyright thereon shall be relinquished, and the work shall become part of the public domain". Sixty-five contributors to these three volumes have achieved, in the words of a previous reviewer, "a brilliant and amazingly successful piece of co-operative authorship", and the radio, scientific and engineering world is indebted to them for their efforts.

R. L. SMITH-ROSE

POPULATION POLICY IN GREAT BRITAIN

Population Policy in Great Britain

A Report by P.E.P. Pp. viii + 228. (London: Political and Economic Planning, 1948.) 15*s*. net.

ARE the British people able and willing to maintain their numbers, and is it desirable that they should? If, as anticipated, the reply is affirmative, how can we ensure that our children shall be naturally well endowed and properly equipped as members of society to face the difficult years ahead? P.E.P., in answer to these basic questions, assumes that British society will remain democratic in its devotion to individual freedom and that the principles and practice of a future population policy—unfortunately, not yet even dimly discernible!—will be in harmony with our traditions.

In the decade that preceded the Second World War, British opinion was roused by contemporary prophets to the dangers of depopulation, then forecast as ultimately certain if not imminent. In these immediate post-war years, however, the prediction has been at least temporarily disturbed by a buoyant birth-rate, notably that of 1947, which was higher than for any previous year for a quarter of a century. The report depends on the assumption—to P.E.P. the only prudent one in the light of all the available evidence over a prolonged period—that, notwithstanding temporary spurts of fertility, the total number of people in Great Britain by 1970 will have become stationary or will be on the decline. (In such predictions the non-intervention of unforeseen, cataclysmic events is, of course, assumed.) The report, in eloquent appreciation of the danger to the nation and patriotically inspired, hopes to stimulate Britain to a reversal of the expected calamitous decline in both numbers and national vigour.

In the light of racial and cultural affinities, it comes with no surprise to learn that population trends in Britain closely resemble those of our nearest continental neighbours. Britain's problem is that of all Western Europe, as nowadays the region is politically and ideologically conceived, and our international colleagues seem no more prepared than we are to meet the challenge of a falling birth-rate. The position in Eastern, Slavonic, Europe is notably different and likely within relatively few years to alter the balance of man-power in the Old World. From the Office of Population Research of Princeton University comes the estimate that, whereas in 1940 in Europe (without the U.S.S.R.) the percentage of total man-power made up of men of fifteen to thirty-four years was little more than 50, in the Soviet Union it was 61; and the forecast that in 1970 the advantage of the great eastern Power will be even more. As the report under notice tersely remarks, the political and economic implications of these estimates require no emphasis.

For Western Europe alone, the report fails to underline the important differences in geographical fortune between the various countries: it deserves emphasis that Britain, apart from Belgium, is easily the most densely populated of the occidental Powers, its economic and social prosperity more vulnerable than that of any to the threat from an ageing population. The assumption that Britain is not overcrowded, but rather the victim of a geographically unbalanced distribution of its inhabitants which

can and will be corrected, would seem to be too readily accepted; as also the likelihood of our being able to disperse the almost unparalleled congestion of our towns, preserving at the same time both the agricultural soils—our richest material possession—and the scenically attractive zones of Britain on which the physical and mental health of the nation increasingly depends. The suggested alternative to the establishment of new urban centres at Crawley, Stevenage, etc., of their transference to the under-populated Dominions, shows the authors to be aware of the possible danger which some observers consider inevitable in the present official policy of 'new towns for old'.

There is much valuable discussion of an 'optimum' population, without, however, an approximation to the most advantageous total for the British Isles. That it should be larger than the present and continue to expand—with an average of 2·5 children per family—is regarded as axiomatic; indeed, on that basis the entire argument and consequent proposals rest. Yet there is neither criticism nor discussion of the recent assertion of an official Australian spokesman (here quoted) that "the best population for Britain would be 30 millions". There is commendable insistence, however, that the attainment of a numerical target is not so vital as the removal of existing obstacles to parenthood and an improvement in the quality of the population.

In these critical years the youth of Britain, whose welfare is the *sine qua non* of the nation's vigorous survival, seems likely to be tempted away on a scale of emigration unknown since the trans-Atlantic migrations of the late years of the nineteenth century. Largely in consequence of the two World Wars, the new countries which exert a powerful 'pull' on British youth have passed from being debtor to being creditor nations, able to provide capital for the opening-up of their undeveloped territories and for large-scale settlement. But Britain, after two generations of declining fertility, can no longer be complacent at the prospect of losing by emigration the youngest and most enterprising of its citizens. The Dominions should be prepared for the proposal that large-scale migration from our shores should represent a cross-section of the British population, both by age and occupation. How this could be effected without recourse to compulsion would inevitably be one of the more urgent topics for the consideration of the research institute for Commonwealth population questions, the establishment of which is one of the many wise proposals of the report.

Although the mortality-rate and the expectation of life in Britain leave scope for improvement—as New Zealand's superior figures under both headings show—they are satisfactory when compared with those of the great majority of Western nations, and it is not in these directions that anxiety exists. Both popular impression and investigation of the causes of the decline in the natural increase of our population leave no doubt that easily the most potent of these causes is the voluntary limitation of families by parents whose motives, however accurately guessed, cannot be certainly known without the thorough investigation now demanded. It is certain, however, that the practice of family limitation has spread from the class of highest social status to the lowest, and that with it has gone a narrowing of the gap between both their respective birth-rates and their respective cultural standards.

That parenthood is increasingly a matter of choice must be positively welcomed; but only so long as it is inspired by confidence in the destiny of both the nation and the civilization it represents. Without this sense of destiny on the part of the community, the work of the social reformer inevitably meets frustration; which certainly is an aspect of the population problem requiring the most earnest attention.

WALTER FITZGERALD

HERBS AND DRUGS

Drugs from Plants

By Dr. Trevor Illtyd Williams. (Sigma Introductions to Science, 10.) Pp. 119 + 12 plates. (London: Sigma Books, Ltd., 1947.) 6s. net.

THE popular appetite for information about the healing virtues of plants has been abundantly catered for by books written from the angle of herbalism. It is a long and honourable tradition, and few incidents in the history of science can be better known to the layman than the original stimulus that came to the study of plants from the appreciation, however imperfect, of their value to medicine. Unfortunately, the outlook of these modern near-herbals remains medieval, and little popular attention has been directed to the large number of important vegetable drugs in the modern pharmacopœias and to the fact that their number, as witness curare and penicillin, is still increasing. There is undoubtedly room for a book that will do something towards making clear to the layman the distinction between herbs and plant drugs.

In a series of introductions to science this title is an excellent, indeed almost an inevitable, choice; and the main problem confronting the author has been that of selection from the riches offering themselves. Plant drugs are of all degrees of significance, from morphia, without which, it has been said, few would be willing to practise medicine, to valerian, about the usefulness of which practitioners still fiercely argue. With only 119 pages at his disposal, the author has followed the sensible plan of selecting a few pre-eminent examples for discussion, and his choice has fallen upon quinine, followed by digitalis, penicillin, ergot, opium and cocaine. The last two raise the problem of drugs of addiction, and the author has added hashish (marihuana) for good measure. Other important plant drugs are briefly catalogued in a single chapter.

The author states his opinion that works of popular science should be entertaining; and it is also evident that he believes a dreadful example should live up to its name. The subject in hand lends itself so readily to sensationalism that in an account addressed to non-technical readers it is hard to know where an objective statement of fact ends and a desire to horrify begins. Suffice it to say that neither the author nor this reviewer has flinched.

On its technical side the subject straddles chemistry, botany, pharmacology and half a dozen other related arts and sciences. This is a formidable list for any publicist to tackle. His apprenticeship to chemistry has enabled the author to do what may be done towards explaining to laymen the structural chemistry of the very complex substances involved. He has not always been so happy in other branches. References to 'female flowers' have got many a botany student into trouble; *Atropa belladonna* is

not a tree, and its leaves contain about a twentieth of one per cent of total alkaloids, not "½ per cent of pure hyoscyamine". Other statements calculated to cause a similar degree of discomfort to botanists occur here and there. Pharmacologists in Britain rarely use cats to standardize digitalis preparations; frogs are generally used. More important, since it involves an analytical principle, it is no longer correct to say that the unit of potency is defined as the quantity of digitalis necessary to stop the heart-beat of an anæsthetized cat or to kill a frog. It is defined as the potency of unit weight of an arbitrarily selected and carefully maintained standard preparation.

This little volume is not a technical handbook, and such inaccuracies are therefore of small account. What is valuable is its method of approach; and the layman who wishes to get a first appreciation of 'Nature's remedies' may do so here along sound lines.

W. O. JAMES

DEVELOPMENT OF SYNTHETIC RUBBER IN THE UNITED STATES

Buna Rubber

The Birth of an Industry. By Frank A. Howard. Pp. xii + 307. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 21*s.* net.

THE author of this excellent book was, until his retirement in 1945, vice-president of the Standard Oil Co. (N.J.), of which he was principal executive for more than twenty-five years, directing and organising research, technical development and other related activities. He is probably the only man who is in a position to tell the story of the birth and development of the synthetic rubber industry in the United States, and he does so with a detachment which makes one almost forget that he was in the centre of the stage during the whole of the time and that, but for his faith and persistence, synthetic rubber might not have been produced in the United States in time to prevent a calamity.

The book falls naturally into two parts, the first dealing with the period from 1919 until 1939, and the second with the war years.

Co-operation between the Standard Oil Co. and its subsidiaries of America and the I.G. Farbenindustrie of Germany led to the formation in 1929 of a joint company, the Standard–I.G. Company, for the purpose, among other things, of enlarging co-operation in research and development on new products and processes. The final result of this co-operation brought to America the technique of the preparation of Buna *S*, an all-purpose synthetic rubber better known in Britain as *GR-S*, obtained by the copolymerization of butadiene and styrene.

The author tells how he instigated the original approach to the German company and of the liaison work which he afterwards carried out. He had realized in the early 'twenties the enormous potential value (to his country) of an all-purpose synthetic rubber, and his Company tried to interest rubber manufacturers in Buna *S*. Quite naturally, however, they were apathetic, as there were ample supplies of the natural product, and the Government was not prepared to subsidize the necessary development work even after the start of the War in Europe. Howard tells with what sense of urgency he and his colleagues regarded the necessity for the setting up of a synthetic rubber industry and how, in the face of general apathy, his Company decided to erect the necessary plant for the manufacture of Buna *S* on a small scale.

Even after Pearl Harbour, all their efforts to get this vital material made on a large scale came to nothing time and time again, until the setting up of the Baruch Committee in August 1942; and the resulting appointment of a rubber director with absolute power cleared away all the difficulties, with the result that in a very short time the American synthetic rubber industry was among the largest in the country.

This book is so outstanding that it is unfortunate that, in Great Britain at least, the title may have the effect of limiting its readers to rubber scientists; but it is so well written and tells its thrilling story in such a clear and unprejudiced manner that it should command a much wider audience.

The printing and binding are first-rate and the only errors detected were "Briton" for "Britain" in what may be considered a controversial passage on page 110, and the spelling of the surname of Wallace H. Carothers with a 'u'. The appendix of 51 pages will be much appreciated by those readers who wish to delve more deeply into the history of Buna *S*.

C. W. LONG

PROCESS HEATING IN INDUSTRY

Industrial Applications of Infrared

By James Doyle Hall. Pp. x + 201. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 21*s.*

IN 1938 publicity was first given to the use of radiant heat from electric lamps for the acceleration of paint drying. Since then the technique has been developed and extended, and now radiant heating is being used in many different industrial processes. Other sources of heat have been introduced. The present book, written by a lamp engineer, is concerned primarily with the use of electric lamps; and it describes in some detail the properties and design of lamps, reflectors, conveyors and other associated equipment for a very wide range of applications. A most notable feature is the inclusion of more than a hundred illustrations of working installations.

A few pages are devoted to 'radiant cup' gas burners; but no mention is made of the radiant plate type of oven which is quite common in Great Britain; nor is there any reference to the industrial use of electric heaters with nickel–chromium elements for giving higher intensities of radiation than are possible with lamps.

Within the limitations which the author has set, the book presents the case for radiant heating in a clear, attractive and readily usable manner, and it should be of considerable help to production engineers. It does, however, suffer to some extent from its own limitations. The case for lamp heating might have been stronger if the book had included a balanced comparison with other methods of process heating which are widely used in many of the fields discussed in the book.

M. R. GAVIN

The Journal of the Institute of Metals

Vol. 72, 1946. Edited by N. B. Vaughan. Pp. lvii+732+80 plates. (London: Institute of Metals, 1946.) £3.

VOLUME 72 of the *Journal of the Institute of Metals* contains 721 pages of text together with an index occupying another ten pages, and fully maintains the high standard expected from this publication. Practically every aspect of non-ferrous metallurgy coming within the scope of the Institute is represented in the twenty-six papers, together with the discussions and correspondence upon them. To the metallurgist, the engineer, and the physicist concerned with the fundamentals of the metallic state alike, there is a direct appeal. The presidential address of Col. P. G. J. Gueterbock is of more than normal interest to those concerned with the health of the metallurgical industry as a whole, and the thirty-sixth May Lecture by Prof. N. F. Mott illuminates the relationship between atomic physics and the strength of metals. Of the remaining papers, the effects of residual stresses are considered in relationship to the fatigue of aluminium alloys; and Lunt and MacLellan give a detailed mathematical treatment of the wire-drawing process. H. W. L. Phillips deals at length with the alloys of aluminium containing magnesium, silicon and iron, and has an interesting account of the application of some thermodynamic principles to the liquidus surfaces of these materials. Corrosion problems, which have always interested the Institute, are dealt with in four papers, of which one may perhaps particularly mention that of Dr. Cuthbertson on the resistance to sea-water corrosion of some α-tin bronzes. The structure of ingots and castings is the theme of three papers; ageing effects of three more, and fatigue problems crop up repeatedly. There will, in fact, be few concerned with non-ferrous metallurgy to whom some of the contributions are not of direct appeal.

Considering present-day difficulties, the editor and his staff are to be congratulated on an admirably produced volume, and on the illustrations, which, as usual, attain a very high standard.

Swelling and Shrinking

A General Discussion by the Faraday Society held at the Royal Institution on 24th, 25th and 26th September, 1946. (Transactions of the Faraday Society, Vol. 42B.) Pp. 304. (London and Edinburgh: Gurney and Jackson, 1946.) 20*s*.

THIS publication brings together the series of thirty-four papers read at the Royal Institution meeting in 1946, together with summaries of the discussion which took place and some subsequent communications. An account of the discussion appeared in *Nature* shortly after the meeting (**158**, 571; 1946), and need not be duplicated here. It is only necessary to commend this volume as a most useful reference book for all who are interested in any aspect of the physical interaction of polymers with liquids. The field covered is extremely wide, ranging from aqueous systems possessing a well-defined structure which can be studied by X-ray methods to non-polar systems in which the components show a close approximation to random mixing.

As usual in the Faraday Society discussions, the subject is covered in an extensive rather than an intensive manner. This volume will therefore be found extremely useful as a first source of information, and it serves this purpose the more admirably in view of the fact that specialists from so many different fields have contributed, thus bringing together under a single cover papers which might otherwise have been scattered through a wide diversity of journals.

Visages de la mathématique

Essai de semi-vulgarisation de quelques aspects fondamentaux de la pensée mathématique. Par Dr. Pierre Defrise. Pp. 126. (Bruxelles: J. Lebègue et Cie., n.d.) 60 francs.

MATHEMATICAL research has two aspects. The more obvious is the solution of problems which arise in the branches of the subject already known. But there is also the logical and philosophical study of the foundations of mathematics, and of the relation between its different branches. Strangely enough, it is the second aspect as well as the first which is indispensable for a full understanding of modern physical theories, such as relativity and quantum mechanics. Dr. Defrise believes that a real understanding of science is impossible without at least a general idea of this second aspect. He has therefore tried to give a treatment of non-Euclidean geometry, the 'axiomatic method', the theory of groups, invariance and transformations, in a form requiring no knowledge of mathematics beyond the ordinary school course and suitable for the non-specialist reader. But this reader must possess a logical mind and a capacity for abstract thought which are not characteristic of 'the man in the street' in Great Britain, whatever is the case in Belgium and France. However, the reading of this little book would be very profitable, if not always very easy, to teachers of elementary mathematics in Britain, as Dr. Defrise's emphasis is on that aspect of geometry which is entirely omitted from our ordinary school course. H. T. H. PIAGGIO

A Picture Book of the Whole Coast of England and Wales

An Account of Variety in Scenery and its Causes. By J. A. Steers. Pp. vii+36+148 plates. (Cambridge: At the University Press, 1948.) 10*s*. 6*d*. net.

THE first Minister of Town and Country Planning commissioned Mr. J. A. Steers to carry out a personal survey of the whole coast-line of England and Wales and to present an assessment of its varied scenery which might serve as a guide should legislation to conserve the coast from further spoliation be regarded as necessary. The results of the survey were published as a large volume, "The Coastline of England and Wales", issued by the Cambridge University Press. In order to make the unique collection of 115 photographs available to a wider public, the publishers have reproduced them, together with thirty-one others and two colour-photographs, in this attractive picture book. A map shows the position of each picture, and there are brief notes on each; while in fifteen informative pages the author has dealt with the chief types of coast and the origin of each. The photographs are remarkable in that they avoid hackneyed subjects and often present well-known views from an unusual angle. The Royal Geographical Society has permitted the reproduction of the map assessing coastal scenery, and Dr. Fraser Darling contributes an introductory essay. The result is a book which can scarcely fail to whet the reader's appetite for a taste of the larger volume.

L. D. S.

COLOUR VISION

DURING the last few years, an air of dissatisfaction has become apparent in some quarters over the adequacy of the orthodox colour vision theories to explain the facts. There has even been some dispute about the facts themselves; but there is at least agreement that since one wave-length can be distinguished from another by its colour, some mechanism of colour discrimination must exist in the retina. All the theories have something in common, in that they all assume that there must be more than one type of receptor in the retina, the types differing, *inter alia*, in their spectral sensitivity. Given these different receptor types and assuming that they can send messages to the brain which give rise to distinctive colour sensations, then we evidently have the essential ingredients for a colour discrimination mechanism. Current argument is largely concerned with the probable number of these distinctive receptors, ranging from the two anatomically distinct types as suggested by Dr. E. N. Willmer on histological grounds to seven as postulated by Prof. H. Hartridge in his polychromatic theory. Three has previously been the most popular figure—a choice stemming from colour-mixture experiments.

This question was the subject for a full-day discussion in Section I (Physiology) of the British Association during the recent meeting at Brighton. The discussion was opened by the presidential address to the Section given by Prof. H. Hartridge, in which he elaborated the arguments in favour of at least seven different receptors. He referred to a number of phenomena which he felt were inadequately explained by existing theories, among them the suppression of the colour fringes which must be formed around the image of a point source of light according to reliable data on the chromatic aberration of the eye, and also the changes in colour which occur when the angular size of a test object is reduced, particularly the change from yellow to white and blue to black. The suggestion that this was due to the blue-blindness of the central fovea could not, he said, be upheld, since similar changes were observed all over the retina; moreover, the changes could be reversed by increasing the intensity of the stimulus.

Another piece of evidence which was difficult to reconcile with the trichromatic theory was the notch in the luminosity curve in the yellow part of the spectrum, as observed by Sloan and by Wright under certain conditions of reduced field-size and reduced illumination. The explanation, as he conceived it, was the existence of a yellow receptor which, when the stimulation was reduced, became inactive and consequently left a dent in the luminosity curve. He also felt that the colour-mixture curves—the dichromatic coefficient curves—obtained by Willmer and Wright under small field conditions were so different from the normal trichromatic coefficient curves that they could not be interpreted merely in terms of the inactivity of only one receptor out of three.

One difficulty faced by any theory postulating a number of different colour receptors was the close similarity in the value of the visual acuity obtained both for white light and for various monochromatic lights. It might be expected that stimulation with monochromatic light would leave a considerable proportion of the retinal receptors either inactive or with greatly reduced activity, so that there would in effect be considerable gaps between the receptors actually functioning. This might be expected to lead to a marked loss of resolving power, and Prof. Hartridge was not prepared to accept the idea that involuntary eye movements caused the image of an acuity test object such as a Landolt ring to be scanned by the retinal mosaic, in much the same way as a television picture is scanned. He considers that the evidence on eye movements at present available does not support the idea that any such scanning takes place.

Moreover, when he studied the question of the fixation areas of the retina used for different colours, he has found from experiments with his microstimulator that different areas appeared to be used for different colours, and he claimed to be able to map out such fixation areas on his own retina. Also, as had been suggested many years ago by Holmgren and by Fick, a small white point of light appeared in different colours according to the point on the retina used to view it.

For these and other reasons, Prof. Hartridge believes that the different colour receptors tend to be arranged in clusters and that while there are three main types of receptor—orange, green and violet receptors—there are in addition a smaller proportion of red, yellow, blue-green and blue receptors. He visualized them as having fairly narrow spectral sensitivity curves on the lines of the modulator curves reported by Prof. Granit, and although he conceded that foveal vision might be nearly trichromatic, he believes that the peripheral retina is certainly polychromatic.

Following the presidential address, shorter papers dealing with different facets of the same problem were given by Dr. K. Tansley, Dr. W. D. Wright and Dr. E. N. Willmer. Dr. Tansley reviewed the electrophysiological evidence provided by Prof. Granit's experiments. She emphasized that the existence of a receptor mechanism with a sensitivity which varied with wave-length was not in itself evidence for a colour perception mechanism, and she also pointed out that although the nerve impulse records obtained by Granit were single fibre records, the condition of stimulation in which a large area of the retina was illuminated made it virtually certain that the response was, in fact, the integrated and interacting resultant from a number of receptors. Studies on a variety of retinæ—snake, frog, cat, etc.—had revealed not only the scotopic sensitivity curve associated with the rods and the photopic sensitivity curve associated with the cones, but also much narrower curves described by Granit as modulator curves. These curves were sometimes recorded as humps on the broader sensitivity curves, sometimes as individual narrow curves; they had also been derived from a comparison between the sensitivity of the retina before and after light adaptation. Some seven modulator curves had been reported altogether, although only in the case of the cat had all seven been found in the same type of retina.

As a result, however, of the development of a polarizing technique in which records were obtained from a retina while a polarizing electric current was being passed across the retina in a given direction, Granit now appeared to be of the opinion that these seven modulator curves were in reality the result of interaction between three groups of receptors the

maximal sensitivity of which occurred in the spectral regions of 450, 520 and 610 mμ.

Dr. Tansley acknowledged that these conclusions could only be extended to human vision, particularly human foveal vision, with some hesitancy; because whereas the cat's retina, for example, exhibits elaborate cross-connexions, the human fovea has much more direct connexions between receptors and optic nerve fibres. It was also true, as was mentioned in the discussion, that the animals investigated by Prof. Granit were not believed to possess colour vision; but Dr. Tansley explained that the micro-electrode technique had in practice proved much more difficult to apply to a retina such as that of the pigeon, which was capable of colour discrimination.

Dr. Wright dealt with the elements of colour-matching phenomena, and showed that, even if there were a yellow receptor, the sensation of yellowness could not be uniquely associated with its stimulation, since yellowness can also be produced by a mixture of monochromatic red and green radiations and therefore by the combined activity of the red and green receptors. It followed that any phenomenon observable with a yellow pigmented surface as test object must certainly involve the red and green receptors, since such a surface reflects light over a wide band of wave-lengths from the red to the green region of the spectrum, and the yellowness of the surface would arise primarily from the simultaneous activity of the red and green receptors. Thus the change from yellow to white with field-size could not be associated either with the presence or absence of a yellow receptor and could provide no evidence for or against such a receptor.

Again, the fact that the additive mixture of red, green and blue radiations produced colours which were too desaturated for an exact match of the colours in the spectrum was easily explained on the assumption that no physical stimulus, particularly no green stimulus, was capable of stimulating only one receptor and therefore of giving a physiologically pure response. This would naturally be the case if the sensitivity curves of the trichromatic theory were broad curves overlapping to some considerable extent. It was, in fact, quite easy to explain the calculations associated with colour-mixture experiments by analogy with an alloy having only three constituent metals.

Three processes were thus adequate to explain colour-matching phenomena and gave the simplest picture of a suitable mechanism, although trichromatic colour matching did not in itself prove conclusively that more than three types of receptor were impossible. The strongest positive argument for only three processes came from the stability of a colour match under a wide range of light and colour adaptations. If more than three processes were involved, then it would not be expected that as their relative sensitivities were changed in various ways by different adaptations, the same combination of only three stimuli would continue to provide a match of any given test colour.

Dr. Willmer approached the subject from the histological and anatomical point of view, and had been led to his hypothesis in an endeavour to explain colour perception in terms of the two types of receptor known to exist in the retina—the rod and the cone. He accepted the need for three mechanisms to satisfy the requirements of colour-matching data; but regarded the third process as arising from a distinction between the sensitivities of more centrally placed high-threshold rods and peripheral low-threshold rods, and from high-threshold rods working in combination with cones, as rod-cone units. He referred to the three chief types of bipolar cell as described by Polyak, namely, the midget, the flat and the mop bipolar, and suggested that these might be associated with the three processes. The absence of the mop bipolar in the central fovea would fit in with the dichromatism and tritanopic character of this area of the retina; but the validity of his theory hinged very much on the question of whether the fovea was populated purely by cones, or whether receptors that he has described as high-threshold rods were also present. On this point he considered the evidence was inconclusive. He also referred to Prof. W. E. Le Gros Clark's work on the lateral geniculate body where, from studies of the degeneration following lesions or damage to the optic nerve, three distinct cell groups had been observed. From considerations of their anatomical association with particular areas of the retina, Willmer suggested that group *a* of larger cells might be linked with the blue receptors (low-threshold rods) outside the central fovea, while groups *b* and *c* of smaller cells were linked with the green (rod-cone units) and red (cones) receptors both in the fovea and extra-fovea.

In the general discussion which followed, the merits of these arguments were considered at length, and it was apparent time and again that the impossibility of linking a given subjective phenomenon with a specific physiological process left the door wide open for speculation. This was illustrated, for example, by a reference to the Stiles–Crawford effect of the directional sensitivity of the retina. Until the origin of the directional sensitivity is known, the variation of the effect with wave-length can scarcely be used as very strong evidence for either this or that theory.

Prof. R. A. Morton brought the discussion to earth when he described the possible photochemical substances which might exist in the retina; and while he suggested, for example, that it was possible that retinene could exist in different ionic states in the retina, yet it was hard to believe that more than three, or at most four, light-sensitive substances could co-exist there at the same time. He pointed out that since these three or four substances might fade at different rates, the different combinations that might occur at different times could give the illusion of more than three or four primary substances. In reply to a specific question from Prof. Morton, Prof. Hartridge hesitated to claim that there were seven distinct light-sensitive substances in the retina; yet if the polychromatic theory were correct, there would presumably have to be some distinctive chemical characteristics which differentiated one receptor from another.

Prof. Morton admitted that the photo-chemists had been given a clear challenge to discover what light-sensitive substances were to be found in the retina, and we have probably to become reconciled to the idea that until the more objective methods of histology, chemistry and electro-physiology have unravelled more of the secrets of the retina, theories of colour vision must remain more or less speculative. So many odd phenomena have to be explained, some quite trivial, some of fundamental importance, that the protagonist of any theory would have a hard task to convince the sceptics that his theory was complete in every respect, and he would probably be unwise to attempt it.

MARINE FISHERIES OF GREAT BRITAIN

ON September 13 a symposium on fisheries was held by Section D (Zoology) of the British Association, under the chairmanship of Prof. H. Graham Cannon.

Mr. Michael Graham opened with a paper on the theory of fishing, as it had developed since T. H. Huxley's common-sense dictum of 1883. This was that if natural mortality took more fish than the fishermen did, it was useless to regulate fishermen, whose efforts had no appreciable effect on the number of fish in the sea. In the meantime, history has shown that, in the demersal fish stocks near the British Isles, there is a persistent downward trend in catch per unit of effort, culminating in a chronic state of no profit in the 1930's. Marking experiments gave returns of 36 rising to 40 and 55 per cent of plaice returned within one year of marking. In order to put the facts in their places, it has been necessary to develop a theory of fishing. Now that eleven nations have signed the agreement of 1947, by which they will take a variety of useful measures as a start, it is necessary to state the theory in the universal language of mathematics, so that all parties can assess precisely what is advocated. The theory, as developed by the Ministry of Agriculture's Fisheries Laboratory at Lowestoft, began with Huxley's dictum about natural mortality and mortality by fishing; and added the factor of growth, because it is a fall in weight rather than in numbers that hurts the fishermen. The latest form of the theory is an equation by Beverton and Holt, which enables conservative measures, such as mesh regulation and control of fishing power, to be measured against each other in terms of the steady yield that would be obtained under different conditions. Attention was directed to Huxley's attack on any regulations that were not supported by strong evidence, and it was emphasized that the onus for showing the need for regulation should always lie on those who advocate it.

It was, therefore, quite in keeping that Mr. E. Ford should follow with a paper directing attention to the strong individualism of fishermen, as perhaps their most marked common trait. He has found the same individualism in fishery research workers, and said he suspects that it is also characteristic of fish! Mr. Ford made it clear that he regards these manifestations as important, and pleaded against their submergence in team-work. The chairman supported him in this; the present writer had not the opportunity of pointing out that strong individualism is characteristic of the members of all good teams, as may be checked by observations in any cricket pavilion. Probably Mr. Ford and also the chairman meant to attack petty hierarchies. It was clear that, as Mr. Ford sees it, the main problem of organisation of research, or of any other activity, is the use and encouragement of individuality, not its smoothing or repression. As it was put to 'Alice', "What does 1 + 1 + 1 . . . make?"; and Mr. Ford sees each 1 different from the others. It is respectfully suggested that the answer to this problem is the team, as properly understood.

In refreshing contrast to the preceding two papers, Mr. G. A. Steven gave a straightforward account of a piece of descriptive fishery research, namely, the elucidation of the seasonal cycle in the mackerel of the Celtic Sea. Contrary to general belief, the main spawning ground of the mackerel is in an area as big as Cornwall, lying over the edge of the continental shelf south of Ireland. Spawning takes place in summer, shifting to the eastward from April to June; but the movement of fish successively joining it is westerly. During the winter, the mackerel is a demersal fish, lying near slopes in the depth contours, for some reason as yet unexplained. Turning to races of mackerel in other parts of the world, Mr. Steven has found evidence of a similar behaviour pattern, correlated with depth, but naturally producing superficially different appearances where the depth contours are differently orientated. Thus, spawning in the Skagerak is crowded in to the coast, and so on. Prof. W. Garstang expressed the pleasure of the meeting at listening to Mr. Steven's vivid account of this work, and referred to his own interest in the subject more years ago than he claimed to remember. As a fishery naturalist at Plymouth, he had found that while all the European mackerel populations resemble each other closely, the North American mackerels are distinguished clearly, in samples of as few as a dozen, by having more spots in their pattern, and in other meristic characters.

Prof. J. E. G. Raymont gave an account of the now famous experiments on fertilization of Loch Sween, especially of the effects in increase of fauna of the loch bed—Chironomids, *Cardium*, etc. Bar the possibility of the effects being by ill-chance due to natural fluctuations—a point raised later by Dr. Cole in discussion—the results showed very clearly how fertilization with nitrate and phosphate had led to notable increases in benthos, time-lagged compared with the increases in plankton, and persisting for a year or so after fertilization had ceased. Increased growth of flounders and plaice followed, achieving values equal to the best natural areas. Prof. Raymont called for extension of the work to an inshore area of the more open sea; but in the discussion that followed, doubt was expressed whether a suitably self-contained area could be found.

For Mr. A. R. Margetts and himself, Mr. S. J. Holt read a paper on the effect of the War on the stock of plaice. Using Beverton and Holt's equation, already given by Mr. Graham, they had worked out what the density of plaice at the end of five years rest from fishing should be, on the basis of data of growth and mortality from the inter-war period. The estimate agreed fairly well with the actual density in 1945, obtained by back extrapolation from 1946, in which year the series of observations was renewed. However, not all the plaice in the North Sea enjoyed a respite from fishing. The younger fish on the eastern side of the North Sea suffered increased fishing from an augmented Danish fleet. The resulting thinning probably accounted for the increased growth-rate found in the younger fish, and it was only after the necessary allowance had been made that the theory gave precisely the same result as the actual, namely, five-fold. In order to take account of changes in growth-rate with changed density of stock, resulting from changed fishing-rates, the authors had used conclusions from Dr. Ben Dawes' experiments on growth of plaice in relation to food supply, supported by Margaret Brown's work on trout. With these they again applied the equation for the yield of a fishery, but with the plaice in the position of the fisherman, and the food of the plaice as its 'fish'.

In the symposium as a whole, the present writer got the impression that many zoologists preferred the more robust factual papers, and regretted the necessity for mathematical theory—useful as it has been in the more delicate and abstract sciences of physics and chemistry. MICHAEL GRAHAM

INBREEDING AND HYBRID VIGOUR IN CROPS AND LIVESTOCK

AT the British Association meeting in Brighton, Sections M (Agriculture), K (Botany) and D (Zoology) held a joint discussion on September 10 to discuss "Inbreeding and Hybrid Vigour in Livestock and Crop Improvement". The chair was taken by Sir John Russell.

The symposium was opened by Dr. J. M. Rasmusson, director of the Swedish Sugar Company's Breeding Institute, at Hilleshög, Sweden, with an account of his extensive work on the improvement of Swedish sugar beet. The chief effects of inbreeding sugar beet are to increase genetical homogeneity and to decrease productivity. At the same time, the adaptability of the plants to varying environmental conditions is lowered while the effects of environmental differences are increased: the plants are, in fact, less able to tolerate and adjust themselves to changes in external circumstances. The chemical constitution of the root, an important consideration in sugar beet, is scarcely affected by inbreeding.

The chief value of inbreeding is therefore to produce lines with specific and reliable features. It may also be of use in isolating lines in which troublesome associations between desirable and undesirable characters have been broken by changing the linkage relations of the genes. No practically useful types have been produced by continued self-pollination in Sweden; but a less-rigorous type of inbreeding, based on the use of maternal progenies between which selection is exercised, has given valuable lines. It has been observed, too, that rigorous mass selection, especially where the number of parent plants is kept small in each generation, produces the practically useful results of loose inbreeding.

When these various partially inbred lines have been raised, suitable mixtures of them can be used in bulk crosses. When this is done, nearly all the seed is from crossing though, of course, all the $\frac{n(n-1)}{2}$ crosses possible between the n lines are present more or less equally in the bulk. The bulk crosses are of commercial value because of their high yields and adaptability to environmental circumstances. The more different in origin were the parent lines, the greater the improvement on crossing; and crosses between lines produced by mass selection under different conditions generally excel those between lines raised by selection between maternal progenies. The effect of crossing, like that of inbreeding, on the chemical constitution is small. Sugar percentage may be slightly reduced though not to an extent sufficient to offset the increase in root yield.

Dr. Rasmusson concluded by mentioning a special case of crossing. Tetraploids, produced by colchicine treatment, yield 5–10 per cent less sugar than the comparable diploids. But the triploids from crossing diploid and tetraploid exceed the diploids by some 5 per cent. The triploid lines cannot, of course, be maintained from seed; but bulk crossing of diploids and tetraploids yields a mixture of the three chromosome types the average productivity of which sufficiently exceeds that of the diploid to make it commercially valuable.

Prof. R. A. Fisher next dealt with the genetical theory of inbreeding, which, as he pointed out, is essentially a means of manipulating the genetic materials so as to control their structure and composition. Inbreeding produces lines of predictable behaviour, particularly in their properties in subsequent crosses, even in respect of the numerous genes the effects of which are so small as to preclude their being followed by the mendelian method. Inbreeding is a tool the success of which has been so great in plant improvement that it can scarcely fail to achieve wide use in both plant and animal improvement in the future. Yet a theoretical understanding of its operation seems largely to be lacking, and very diverse opinions are held at present as to the reason for its success.

It is clear that the effect of inbreeding, particularly the production of an inbreeding depression which can be wiped out by one generation's crossing, must imply dominance of the genes concerned, and the genetical theory of the origin of dominance throws some light on how this could come about. The lines isolated by inbreeding differ greatly in their genetical qualities, and selection can be exercised among them at three stages in their production, namely, in the choice of individuals with which to start the inbreeding, in the choice of individuals for continuing the lines during the inbreeding, and in the choice of lines, once established as true-breeding, for use, especially in subsequent crosses. Of these, selection among the established lines is the most valuable, because the true-breeding nature of these lines permits selection based on extensive testing of a wide variety of them. Indeed, this facility offered for increasingly accurate selection is the essential advantage conferred by inbreeding. The rapid improvement in the accuracy of variety trials, made possible by replicated and randomized field designs, has played an important part in refining the selection which has been so successfully practised in the production of hybrid maize.

Mr. G. M. L. Haskell, who followed Prof. Fisher, gave an account of the theory and practice of hybrid maize production. Hybrid maize represents so great an advance over the open-bred varieties which preceded it that it has now replaced the latter virtually completely in the corn belt of the United States. Maize is naturally a cross-pollinator, and genetically the plants are mostly heterozygous. Ordinary methods of selection had shown themselves incapable of materially improving the open-bred varieties of maize before the new methods were introduced. The introduction of the inbreeding technique has led to the production of a great variety of lines which, though all showing inbreeding depression in greater or lesser degree, are uniform and virtually true-breeding and have satisfactory plant characters. Hybridization of inbreds, which is made easy by the monœcious habit of the plants, produces offspring the hybrid vigour of which is often such that they surpass in yield not merely the inbreds themselves but also the open-bred varieties from which these inbreds were produced. Every one of the hybrid plants is a potential yielder, and the hybrid families are uniform

in appearance, time of maturity and disease resistance. The more diverse the parentage of the inbreds, the more likely they are to combine well in giving high-yielding hybrids. Combining properties vary from inbred to inbred and represent a character for which breeding can deliberately be practised.

Mr. Haskell described the commercial methods used in the United States for inbreeding and hybridising maize, both in sweet corn where first crosses are used for commercial production, and in field corn where double crosses, made between two first crosses, are preferred. The special problems of breeding maize suitable for Great Britain in regard to photoperiodism and cold-hardiness were mentioned in conclusion. A feature of Mr. Haskell's paper was the wealth of lantern slides with which all its points were illustrated.

In the fourth contribution to the discussion Dr. H. P. Donald dealt with the use of inbreeding and crossbreeding in livestock production. Breed crossing is not an uncommon practice in animal husbandry. Sometimes it is indiscriminate, particularly where, as in Britain, many breeds are kept. Such crossing is not intrinsically undesirable though it must always indicate a lack of purpose in the breeding aims. Other crosses are made deliberately for purposes such as that of distinguishing the sexes at hatching in poultry. Crossbred animals may also be better fitted to particular environments. For example, the Zebu-cattle crosses in northern Australia combine good heat tolerance and quick growth; but have lost some popularity because of their intractability in handling. In the extreme case breeds might be kept as inbreds solely for the purpose of producing crossbreds. A further type is cyclical crossbreeding, where successive generations are mated to two, three or four breeds in turn. This should conserve the greatest part of any heterosis that the crossbreeding could give without the necessity of always going back to the pure breeds for crossing; but it has yet to be shown that the heterosis so obtained is worth while.

Inbreeding has not so far been widely tested as a preliminary to crossbreeding in livestock, because of the great experimental expense. It is known, however, to result in depression of such characters as viability, fertility and milk production. Many defects like scrotal hernia and cleft palate also appear. Slow inbreeding under selection might help to overcome these troubles, but many of the lines must in any event be discarded. The exploitation of inbreeding followed by crossbreeding is too expensive for the ordinary farmer and must require a new breeding organisation. This has been developed for the 'Hyline' poultry in the United States. These birds resemble double-cross maize in their method of production and they cannot be successfully bred on by the farmer. They show hybrid vigour more in the rate of survival than in the egg production of surviving hens.

The complementary use of inbreeding and crossbreeding in animals has potentialities in three ways: to exploit hybrid vigour, to fit the requirements of new territories, and to improve breeds within their own limits when simple selection ceases to be effective. It remains to be demonstrated, however, in each case whether the gain in production will pay for the labour and expense of the method.

The final paper of the meeting was given by Dr. K. Mather, who discussed the genetical principles and problems of inbreeding and crossbreeding as a method of plant and animal improvement. In inbreeding plants, such as wheat, peas and tomatoes, homozygous lines of uniform excellence can be maintained by the natural breeding system of the crop. This is not possible with crossbreeders, in which varieties and breeds, though in equilibrium from generation to generation, must always consist of a heterogeneous collection of heterozygous individuals. Genetical variation is inevitable and the average of the variety must in consequence always be below the best. The homozygotes produced by inbreeding are always poor in such species. Uniform and predictable groups of heterozygotes can, however, be obtained by artificially crossing these homozygous lines. Thus it is the aim of the method of inbreeding and crossbreeding deliberately to produce heterozygotes uniformly approaching the best individuals of the open-bred varieties and so, as groups, excelling the average of the varieties; and further to produce these heterozygotes consistently generation after generation.

Five problems arise with this method of breeding. First, there is the great multiplicity of inbred lines which can be raised and must be tested. In the past the desirable inbreds have been discovered by trial and error. Those which give the best hybrids are not, in fact, always themselves the most productive inbreds. Combining ability is the critical character of the inbreds, and it is on this character that they must mainly be selected. Quicker methods are needed for sorting out the lines with valuable combining properties from the mass of their less useful fellows.

The second problem is raised by the poverty of the inbreds themselves. They are expensive to keep, and their immediate yield of hybrid offspring when crossed is low, so that hybrid production is costly. Various methods, such as double-crossing and top-crossing, are used to overcome this latter difficulty without sacrificing the chief benefits of the system of breeding.

The method of convergent improvement has also shown itself capable of raising the vigour and productivity of the inbreds themselves.

Thirdly, there is the problem of making the necessary controlled crosses. This is easy in dioecious animals and in monoecious maize; but plants with hermaphrodite flowers require special methods. Cytoplasmically controlled male-sterility has been used for this purpose in onions, and bulk crossing is being exploited in sugar beet.

The fourth problem is raised by the very uniformity of the inbreds and their hybrids. Where only inbreds are maintained there is a risk of loss of the valuable reservoir of genetical variation which is to be found in the open-bred varieties, and in maize special collections of the old types have become necessary to provide sources of future breeding material. In the hybrids the danger of complete genetical uniformity is that it may result in total loss of the crop through a short period of adverse weather, the effect of which on a more variable stand would be much less serious. The production of double-cross hybrids goes some way to overcome this difficulty.

Finally, there is the question of whether the raising and crossing of inbreds pays for itself. In maize and sugar beet it certainly does; but elsewhere the answer is less clear. It seems, in fact, that the answer will not be the same for all species in all circumstances, and any investigation of the practical possibilities of inbreeding and crossbreeding must therefore pay due attention to the economic aspect.

K. MATHER

THE WORLD FEDERATION OF SCIENTIFIC WORKERS

THE first General Assembly of the World Federation of Scientific Workers was held in Czechoslovakia during September 21–25, as guests of the Czechoslovak Association of Scientific Workers. It was attended by thirty-three delegates and observers from thirteen countries (Austria, Britain, Bulgaria, Canada, China, Czechoslovakia, Denmark, France, Greece, Hungary, Poland, South Africa and the United States). Observers on behalf of Unesco and the World Federation of Trade Unions were present.

The business sessions were held in the Castle Dobříš, the magnificent country palace belonging to the Czechoslovak Syndicate of Writers, which is about forty kilometres from Prague.

The Assembly was opened by the president of the World Federation of Scientific Workers, Prof. F. Joliot-Curie. Messages of welcome and greeting were received from the Czechoslovak Ministers of Foreign Affairs, Education and Information, Unesco, the World Federation of Trade Unions, the Czechoslovak Trade Unions, the Czechoslovak Academy of Sciences, and other personalities and institutions.

The chief business of the second session was the presentation and discussion of the secretary-general's report. The secretary-general, Mr. J. G. Crowther, reviewed the activities of the World Federation of Scientific Workers during the two years of its existence. He described how, at the end of the Second World War, associations of scientific workers had spontaneously come into existence in various countries. The formation of a Federation was desirable for the exchange of views, and the formation, so far as possible, of agreed opinions on all questions affecting scientific workers as such.

The World Federation now contains eighteen affiliated organisations, in fifteen countries drawn from all the five continents. The total membership of individual scientific workers is more than twenty-four thousand.

The World Federation has been recognized by Unesco as one of the non-governmental international bodies interested in its work. Accordingly, it was invited to send representatives to the Second General Conference at Mexico City, and to Unesco Commissions on the Popularization of Science and its Social Relations. These representatives proposed that Unesco should found fellowships for research on the social relations of science, an innovation that has been accepted.

The World Federation has initiated a new kind of international ceremony. These are celebrations of great men of science not in the country of their origin. The first was the London celebration of Langevin, the second was the Paris celebration of Rutherford. The third will be in 1949, on the centenary of the birth of Pavlov. The Langevin proceedings have been published, and those of the Rutherford ceremony are in the press.

The resolutions and proposals submitted to the first Assembly were analysed and discussed by four working commissions, dealing respectively with: (*a*) The Organisation and Social Responsibility of Scientists; (*b*) Atomic Energy, Secrecy and Peace; (*c*) Reconstruction, Colonial Countries, and Natural Resources; (*d*) A World Federation Journal, and Finance.

The reports of the four commissions, after amendment and verbal improvement, were accepted by the Assembly in plenary session. The resolutions dealt with the persecution of scientific workers, the unity of men of science against war, the co-ordination and improvement of abstracting services, international holiday camps for scientific workers, the control of atomic energy, secrecy in science, distribution of radioactive isotopes, scientific development in colonial countries, utilization of world resources, the foundation of a Federation journal, and other topics.

A special resolution was passed welcoming the formation of the Permanent International Committee for Peace by the Wroclaw Cultural Congress, and wishing it all success in its struggle for a peaceful world.

The decision to launch a World Federation journal was one of the most important. It is hoped that publication will begin soon, and that the first number will be devoted mainly to a report of the proceedings of the Assembly.

The draft "Charter for Scientific Workers" was discussed in plenary session, and emendations from affiliated associations were incorporated. The Charter was then adopted. The Czechoslovak Minister of Education, M. Z. Nejedlý, who is also president of the Czechoslovak Academy of Sciences, was present at this session. The chairman, Prof. J. Bělehrádek, remarked after the vote that the occasion was historical, for it was the first time in the history of science that scientific delegates from all quarters of the globe had agreed on a definition of their duties and rights as scientific workers.

On the night of September 22 a public meeting on "Science in the Modern World" was held in the Lucerna Hall in Prague. Two thousand persons bought tickets for this meeting. Speeches were delivered by Prof. F. Joliot-Curie (France), Mr. C. M. Liu (China), Prof. S. Maximos (Greece), Dr. K. Z. Bratanoff (Bulgaria), Prof. J. D. Bernal (Britain) and Prof. A. Kolman (Czechoslovakia). Several brilliant speeches were made; but one of the most remarkable was by Prof. Z. Nejedlý, in moving the vote of thanks to the speakers. He revealed an equal understanding in addressing the men of science on one hand, and wit and humour in speaking to the general audience on the other. After the meeting he gave a reception in honour of the Assembly, which was attended by Czechoslovak personalities, the British Ambassador and other members of the Diplomatic Corps.

The Czechoslovak Association of Scientific Workers entertained the members of the Assembly to a two-day tour of their country, in which no less than six hundred kilometres were covered by bus. The main visits were to the Bata works at Zlín, and to Hradec Králové. The famous boot and shoe factory, now nationalized, is at the base of high wooded hills. The architecture is in the most modern functionalist style. Extensions are being built at a great speed, floors being added to buildings at the rate of one a fortnight. The roof of the newest factory is to be a helicopter landing stage. Bata has its own twelve-story hotel. Many of its workers are housed in cubic villas on garden-city lines, and in flats. More than one thousand new flats are under construction. It was stated that Bata employs thirty-two thousand workers, and has a daily output of a hundred thousand pairs of boots and shoes—ninety per cent for export. There is a considerable research organisation, including consumer research. New styles are

tried out on a large scale by employees, who are given the footwear free, and are then asked to report on attractiveness, comfort, wear, etc.

Members of the Assembly also visited the new Medical Faculty, created at Hradec Králové in 1945. The building, which had been a military school, and had been occupied by the Red Army, was vacated by the Soviet Commander in order to provide accommodation for the new school, with the comment that it was fitting that Mars should make way for Athene.

After visiting the Medical Faculty, the members were received at the Institute of Glass Technology, a research and consulting centre for one of Czechoslovakia's chief industries. J. G. CROWTHER

NEWS and VIEWS

Experimental Zoology at Manchester: Dr. Ralph Dennell

THE science of zoology underwent a profound change at the end of the First World War. The orthodox approach to the subject through a study of comparative anatomy was largely abandoned, and all energies were devoted to the new outlook afforded by experimental zoology. Despite this complete change-over, no new academic posts were created to cater for this new method of approach. For a short time, there was a readership at Cambridge, but that was all. Now, to fill this obvious want, the University of Manchester has established a full chair in experimental zoology, to which Dr. Ralph Dennell has been appointed. Dr. Dennell has the advantage of having made his name first of all as a functional morphologist. He commenced work on the feeding mechanism of various Crustacea, and later turned his attention to the luminous organs of certain deep-sea prawns. During the Second World War, he undertook a study of the feeding mechanism of the grain weevil, and this led him to an experimental investigation of the process of hardening of the insect cuticle, a problem which he is extending to the whole of the Arthropoda. At present, he is in Bermuda, with a Leverhulme fellowship, studying deep-sea luminous forms.

Assyriology at the British Museum: Dr. Sidney Smith, F.B.A.

IT has been announced that Dr. Sidney Smith has retired from the post of keeper of the Department of Egyptian and Assyrian Antiquities at the British Museum, and has been succeeded by Mr. C. J. Gadd, formerly deputy keeper of the Department. Dr. Sidney Smith entered the British Museum in 1914 and has been keeper since 1930. There are probably few living Assyriologists who can speak with authority, as he does, not only on textual and philological matters, but also on every subject connected with Near Eastern and Egyptian archæology. He was one of the first to correlate the complicated stratigraphical and epigraphical data yielded by recent excavations in Syria and the Hatay, and his new scheme of chronology published in 1940 is being accepted by an increasing number of scholars. He is a controversialist who does not tolerate loose thinking; but serious students have always had reason to be grateful to him for his constant readiness to place the fruits of his learning at their disposal. It is understood that as professor of ancient Semitic languages and civilizations at the School of Oriental and African Studies, University of London, he hopes to have more time in future for his own researches.

Mr. C. J. Gadd, F.B.A.

MR. C. J. GADD, who in terms of service in the British Museum is only five years junior to Dr. Smith, is an Assyriologist of no less eminence than his predecessor, and is a profound and erudite scholar, whose deep understanding of the ways of thought of the Babylonians and Sumerians is exemplified in his Schweich Lectures, recently published under the title "Ideas of Divine Rule in the Ancient Near East". With his generous and self-effacing personality, he brings to his new appointment the goodwill of his staff and of all who know him.

Festival of Britain, 1951

GENERAL LORD ISMAY, chairman of the Council of the Festival of Britain, 1951, presided at a meeting on October 14 to announce progress in the plans for the Festival. Mr. Gerald Barry, director-general, emphasized that it is hoped to mark 1951 in three ways: by events centrally organised and financed by the Festival organisation itself; by events organised by other interests, which may be associated with and assisted by the Festival authorities; and by unofficial events throughout Great Britain. There is to be a central exhibition in London on the south bank of the Thames between the County Hall and Waterloo Bridge; the river front is to be cleared and a concert hall built on the site. The exhibition itself will be in temporary fabric structures of a new type; it will be on a small scale and an attempt will be made to tell the story of British life and achievement. It was emphasized that it will not be a trade fair. The Council of Industrial Design will be responsible for selecting contemporary industrial exhibits. A Council of Science and Technology, specially created for the Festival, will ensure that scientific achievement will be adequately represented both in the central exhibition and in other ways. An Architectural Exhibition, elsewhere in London, will take the form of a full-scale cross-section of a residential area in various stages of building, which can be completed and handed over for actual use after the Festival closes. There will also be one or more travelling exhibitions visiting the principal cities of the country; and it is hoped to co-operate with bodies holding annual meetings, such as the British Association. Finally, the Vice-Chancellors of the Universities of Oxford, Cambridge and London have been invited to arrange special vacation courses in the summer of 1951 in subjects relevant to the main theme of the Festival. In this way, it is hoped to demonstrate the contribution of British thought in philosophy, literature, religion and science to the progress of civilization.

Research and Recovery

MR. HERBERT MORRISON, Lord President of the Council, addressed the chairmen of councils and directors of the industrial co-operative research associations at a conference in London on October 15. The express purpose of this conference was that the delegates should acquaint the Government of their progress and difficulties in research so that the

findings could be integrated into Great Britain's overall economic programme. Mr. Morrison believes that the first problem of economic recovery is one of increased productivity, and the key to this is to be found in more knowledge—knowledge both of technical processes and also of human relationships. The Government is fully aware of the importance of the issue and is prepared to support State and private research with every financial help; thus the trend of increase in cost—£470,000 in 1938, £2 millions last year and an estimated £2½ millions next year—is not a matter for concern but a sign of the ever-growing importance of research and a pointer to bigger things to come. Recent material results have convinced Mr. Morrison that the money is well spent, and he referred, for example, to the technical advances made in pottery firing operations, infra-red drying of paints, fitting of shoes, adjusting of peak electrical loads, production of linen, improvement of iron foundries and development of 'nodular cast-iron', design of more efficient domestic grates, scientific research into better houses, and the improvement of road surfaces. It is important that manufacturers should bear in mind the improvement of quality and lowering of costs in addition to increased productivity. All these problems can be solved by more scientific investigation, and Mr. Morrison considers that research is the spearhead of the advance of industry by which we will determine whether we are going to hold our place in competitive world industry or degenerate into a third-rate Power. Not only must the value of research be recognized, but also the conditions of scientific workers must be improved and their status acknowledged. Responsible people do realize these points, but are they fully understood by the general public? The research associations must publicize their activities and see that the world knows of the excellent results being obtained by British research effort.

Operational Research Club

ABOUT a year ago, a number of men of science interested in operational research began meeting together in the rooms of the Royal Society to discuss the development of methods and the application of this field of science. Papers were read and discussed in connexion with road traffic, productivity in the cotton industry, use of fertilizers by farmers, the organisation of inspection in the steel industry, etc. An "Operational Research Club" has now grown out of these meetings, and a healthy programme of papers for this session has been planned. In order to maintain the informal nature of the meetings, it has been necessary to limit the membership; but it is intended to include representatives from most of the operational research teams working in industrial and other civil fields, together with some from the defence services. The honorary secretary of the Club is Mr. D. Neville-Jones, 24 Rutland Gate, London, S.W.7.

Motor Industry in Britain

A CLEAR picture of the British motor industry is presented in a broadsheet prepared by Political and Economic Planning (No. 284). The broadsheet traces first the development of the industry before the War, examining factors such as taxation which influenced demand in the United Kingdom and the growth of the Nuffield Organisation, the Ford Motor Co., the Austin Motor Co., Vauxhall Motors, the Rootes Group, and the Standard Motor Co. The effect of conversion to war demands and subsequent reconversion is then described, and, after a review of the post-war structure and home demand, the labour force of the industry is analysed, and its trade organisations and export markets are considered. The broadsheet makes no recommendations as to future policy, but indicates that if the shortage of foreign exchange could be left out of account, there is sufficient shortage of vehicles in the world to give both Britain and the United States ample scope for some time to come. Such comparison with pre-war figures as is practicable suggests that the industry's labour force is about 25 per cent greater than before the War.

The Original Wright Aeroplane

THE original Wright aeroplane of 1903—the first power-driven man-carrying aeroplane to make a free, controlled and sustained flight—was lent by Mr. Orville Wright in 1928 for exhibition in the Science Museum, London, for an initial period of five years. On October 18 it was taken down for packing in crates in readiness for its return to the United States. This machine was designed and built by the brothers Wilbur and Orville Wright at Dayton, Ohio, in 1903, and was flown at Kitty Hawk, North Carolina, on December 17. The first flight lasted 12 sec. and was made in a wind of about twenty miles per hour, the machine being piloted by Mr. Orville Wright; altogether four flights were made on the morning of that day. The last flight was one of 59 sec., when the distance covered was 852 ft.; the machine was then overturned by a gust of wind while left unattended, and the damage caused prevented further experiments at that time. After these first flights, the aeroplane was preserved in the Wright Laboratory at Dayton. Certain parts which were damaged were replaced by Mr. Orville Wright himself, and the machine was restored to its original condition. An exact replica of the aeroplane has now been made and will be exhibited in its place at the Science Museum. Dr. H. Shaw, director of the Museum, is to accompany the machine to the United States, where it will be preserved in the National Air Museum, Smithsonian Institution, Washington, D.C. It should arrive there in good time for the forty-fifth anniversary of its first flight on December 17, 1903.

Economics and State Control

PROF. G. C. ALLEN's inaugural lecture at University College, London, on March 4, 1948, which has now been published (London: H. K. Lewis and Co., Ltd. Pp. ii+18. 2*s.* 6*d.* net), emphasizes that while the trend of economic opinion in pre-war days was in favour of a more active intervention by the State in economic affairs, such intervention was not inconsistent with the preservation of the system of private enterprise; it was deemed necessary for improving the operation of the system. Present policy, however, of State intervention goes much further than the achievement of 'full employment', an acceptable distribution of the national income, and the promotion of structural adjustments in industry by fiscal or financial measures. Prof. Allen devotes most of his lecture to an examination of the economic implications of the policy at present being pursued both in the nationalization of industry and in the guidance of private industry by substitutes for the compulsion of the market. He points out the importance in industries that depend to any extent upon innovation of being able to attract the outstanding personalities with initiative and organising capacity; the administration and efficiency of such industries

will suffer under nationalization if such men are no longer attracted by the conditions of service. Similarly, he discusses the difficult question of effective Parliamentary control over the operation of public monopolies, and suggests that the safeguard of publicity can and should be made fully effective.

Prof. Allen offers no answer to the fundamental question whether it is possible for the State to formulate far-reaching plans for the disposition of economic resources intended to promote objectives of which men in their political capacity approve, and at the same time to afford adequate opportunities in the industrial sphere for the free movements of the mind and will, without which progress is in jeopardy. Certain dangers and problems, such as those of economic discipline, of the transfer of important categories of decision from the individual to the bureaucracy, and the establishment of an administrative machine capable of reaching speedy and wise economic decisions in those fields, and the danger of perpetuating the *status quo* in circumstances inherent in 'gentlemen's agreements' between the Government and organised bodies in industry, are indicated. Prof. Allen, while indicating the limits and dangers of such methods, believes that we are likely to be so hard put to it to find help in pursuing the middle way that we should not reject any method which offers even moderate prospects of success.

Permanence of Residence as a Social Factor

A PAPER by Dr. H. M. C. Luykx, "Family Studies in the Eastern Health District: IV. Permanence of Residence with Respect to Various Family Characteristics", reprinted from *Human Biology*, is one of several studies in a district of the city of Baltimore. Its findings are summed up in a table showing the family characteristics associated with the highest and lowest proportions of families remaining in the district between the triennial censuses of 1933, 1936 and 1939. The highest proportion of permanence was found among whites, owning their houses or paying the highest rent, with children and several wage-earners in family, where the family head was a skilled worker or foreman, middle-aged, foreign born, and not highly educated. With the present concern over labour mobility between industries, this study has considerable 'social significance'. Education, and renting rather than owning houses, seem indicated as favourable factors that social policy can control.

Directory of Natural History Societies

IN December 1943 the Committee of the Amateur Entomologists' Society agreed to compile a Directory of Natural History Societies. Quite independently, Miss R. S. Shove suggested in *School Nature Study* of January 1944 that a list should be prepared of school natural history societies and field clubs. As a result it was decided to trust the entire work to the Amateur Entomologists' Society, the School Nature Study Union agreeing to assist in the preparation of a schools section. In its early stages the compilation was directed by W. G. Rawlings; he was later succeeded by H. K. Airy Shaw. The Directory has now been completed and contains a list of all organisations with any biological interests, excluding bodies of an economic or professional nature. All societies, past and present, of which the Society could find any record in the British Isles, have been included. These have been arranged first to give information about national societies and then local societies, arranged in order of counties. The material arranged under each entry in the Directory is sufficient to guide naturalists in a distant county to a group of like-minded individuals. Not the least important parts of the Directory are the particulars of so many school natural history societies. The Directory can be obtained from the Secretary, Amateur Entomologists' Society, 1 West Ham Lane, London, E.15.

Nairobi Scientific and Philosophical Society

IN spite of the speed of modern communications, the sense of isolation arising among scientific men working in the Colonies and elsewhere overseas is still very real; one way of mitigating the difficulty is the formation of local scientific societies. The Nairobi Scientific and Philosophical Society is such a body, which arose from the need for co-operation between various scientific and technical officers working in Kenya. A meeting was held at Nairobi on April 9, 1947, at which the chairman, Mr. A. Walter, stressed the need for a central meeting place for scientific men, and the first formal meeting took place a month later. Now the Society has been able to issue vol. 1, part 1, of its *Proceedings*, and to claim a membership of fifty within six months of formation; this shows a very creditable interest among the necessarily small number of scientific and technical workers within reach of Nairobi. The *Proceedings* includes accounts of five meetings held by the Society; the subjects dealt with include *radio-sonde* in meteorology, the sociologist in industry, primitive agriculture in the modern world, development planning for the African and hormone weed-killers. The sociological bias shown is accounted for by the facts that advantage had to be taken of the availability of visiting guest speakers, and that the Society itself has arisen in a country where the development of a primitive people is taking place at an unprecedented pace. The Society is to be congratulated on the progress it has made as a centre for the discussion of problems of broad scientific and technical interest in Kenya. The officers of the Society are: *President*, A. Walters; *Vice-Presidents*, Dr. E. B. Worthington and V. A. Beckley; *Joint Honorary Secretaries*, W. A. Grinstead, P.O. Box 931, Nairobi, and H. E. Watson, P.O. Box 560, Nairobi; *Honorary Treasurer*, Dr. D. Harvey; *Honorary Librarian*, Dr. H. C. Pereira.

Earthquake in Iran

ON October 5, a great earthquake shook large areas in the province of Khurasan in north-eastern Iran, together with parts of Russian Turkestan. The large area of destruction appears to indicate either that the depth of focus of the shock was greater than normal, or that there was more than one shock. Two hundred people are reported killed and thousands injured at Meshed, with two hundred killed at Dereges. Askhabad, a Russian town with 150,000 inhabitants, suffered severely, four hundred people being reported killed. Six thousand injured people have been evacuated by air, and a temporary water supply has had to be organised to replace the town's water supply disrupted by the earthquake.

The area is a particularly seismic one, 140 earthquakes of varying intensity having been experienced during the last seventy years, and large earthquakes having occurred, according to Sir Arnold Wilson, at Kuchan in 1852, 1871, 1872, 1893 and 1895, at Meshed in 1673 and 1895, and in the whole area in 1929. This latter shock was also reported in *Nature* of May 11, 1929. On May 1, 1929, twelve distinct

shocks were felt within twenty-four hours at widely separated points, running from Bandargaz to Kalat. The towns of Shirvan, Bujnurd and Jajarm were severely damaged, and a thousand people were killed in Askhabad. A cleft three yards wide is reported to have been opened between the towns of Khaki and Bagham, to a distance of eighteen miles. The total Persian casualties were 3,253 killed, 1,121 injured, 88 villages destroyed and 6,542 cattle injured. Further news is awaited concerning the present earthquake.

International Council of Scientific Unions

THE annual meeting of the Executive Committee of the International Council of Scientific Unions was held at Brussels in September, Prof. E. Borel presiding in the absence of the president, Dr. J. A. Fleming. A resolution from the Royal Society was adopted, that all adhering bodies, national academies and scientific unions be consulted before the Executive Committee accepts any new union. A resolution from the United States asking the Council to consider its constitution and the distribution of subjects covered by the Unions was referred to a committee in the hopes that a report might be available for discussion at the next General Assembly of the Council at Copenhagen during September 14–15, 1949. New joint commissions between the unions were agreed upon to deal with standards and units of radioactivity, spectroscopy, and high-altitude research stations. The adhesion of one new country, Pakistan, was reported. The recommendation from the Committee of Science and Social Relations that a journal should be started by the Committee was referred to the General Assembly. Dr. Establier was reappointed liaison officer with Unesco; representatives of Unesco present at the meeting were Prof. P. Auger and Dr. Wang-hsi-chin.

International Commission on Glass

THE International Commission on Glass held its first post-war meetings at Sheffield and Buxton during September 30–October 2 under the presidency of Prof. W. E. S. Turner. Decisions were taken to revise the constitution of the Commission, and arrangements were made for the preparation of scientific and technical reports on subjects of fundamental importance in glass technology. Until the adoption of the new constitution, the following comprise the International Commission: Prof. A. H. M. Andreasen (Denmark); Prof. J. A. de Artigas (Spain); Dr. B. P. Dudding (Great Britain, *honorary secretary*); Dr. M. Fanderlik (Czechoslovakia); Prof. P. Gilard (Belgium); Dr. J. C. Hostetter (United States); Dr. B. Long (France); Dr. H. Maurach (Germany); Dr. Atma Ram (India); B. Simmingsköld (Sweden); Dr. J. A. Stevels (Holland); Prof. W. E. S. Turner (Great Britain, *president*).

American Physical Society: Division of Fluid Dynamics

THE Division of Fluid Dynamics of the American Physical Society, which was established by the Council of the American Physical Society in June 1947, has been organised, and the following have been elected members of the Executive Committee: Jesse W. Beams, Howard W. Emmons (*secretary-treasurer*), Theodor von Kármán, Hugh L. Dryden (*vice-chairman*), Paul S. Epstein, Raymond J. Seeger (*chairman*), and John G. Kirkwood. The first meeting of the new Division took the form of a one-day symposium on June 23, when the Division joined with the University of California at Los Angeles, the University of Southern California, and the California Institute of Technology as part of a three-day meeting to discuss heat transfer and fluid dynamics.

British Museum (Natural History)

THE southern half of the Invertebrate Gallery (which used to be known as the Starfish Gallery) in the Zoological Department of the British Museum (Natural History) has now been re-opened. The Gallery was dismantled during the War, and an entirely new arrangement of starfishes and other Echinoderms has been prepared, showing many species in their vivid natural colours. Their usefulness to man and their methods of feeding and breeding are among the subjects illustrated in the new exhibit. In addition to Echinoderms the Gallery is being used temporarily to house a full-sized model of a giant squid, and a small selection of shells. These have been chosen mainly for some interesting peculiarity; there is, for example, a display of venomous cone shells. A series of common British shells is also exhibited. Certain groups of small invertebrates are also on view here, notably the great group of worms, including earthworms, leeches, many marine forms and parasites. Another new feature is a large-scale relief map coloured to indicate the main movements of the oceans, and the zoo-geographic regions into which the land masses are usually grouped for purposes of biological study.

National Certificates in Textiles

THE Textile Institute, which is jointly responsible with the Ministry of Education for the award of national certificates in textiles, announces that this year there were 131 entrants for the ordinary certificate, of whom 109 passed, and 85 for the higher certificate, of whom 82 were successful. Fifteen distinctions were obtained in the Higher National Certificate examination. Of the 191 successful candidates, 125 studied cotton subjects, 46 woollen and worsted, and 20 studied general textile subjects.

University of Sheffield: Appointments

THE following appointments have been made in the University of Sheffield: Dr. William Hobson, senior lecturer in preventive medicine in the University of Bristol, to the newly instituted chair of social and industrial medicine; Miss Ellinor I. Black, senior lecturer in the Department of Social Science, University of Liverpool, to be director of the newly instituted Department of Social Studies; S. Armstrong, lecturer in civil engineering; Dr. A. E. Beet, at present demonstrator in fuel technology, to be lecturer in fuel technology; A. W. Nicholls, assistant lecturer in glass technology; P. H. Price, research assistant to the professor of fuel technology; James S. Hough, research demonstrator in botany; P. Wright, Glass Delegacy research fellow.

Announcements

SIR WALTER MOBERLY, chairman of the University Grants Committee, will deliver the Rede Lecture in the University of Cambridge on November 18. He will speak on "Universities and the State".

FOR the future, the Universities Bureau of the British Empire will be known as "The Association of Universities of the British Commonwealth". Its new address is 32 Woburn Square, London, W.C.1 (Telephone No.: Museum 4578/9).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Multiplication of Bacteriophage

As part of a study of how viruses grow, we have been making series of electron micrographs which demonstrate essential steps in the multiplication of the virus-like bacteriophages.

This multiplication has been most easily seen in certain experiments with the *T*(2) bacteriophage against *E. coli*. Frequently transferred bacterial cultures less than two hours old were mixed with filtered bacteriophage suspensions of high titre and incubated for periods ranging from 0 to 30 minutes. At the end of the desired interval, interaction was arrested by chilling the mixture in ice water. The sediment obtained from it by centrifugation was formalinized and washed by repeated sedimentation. In final aqueous suspension it was mounted on collodion-covered grids and shadowed[1] with chromium or palladium.

Electron microscopic observation showed that young bacteria are lysed very soon after coming in contact with the particles of bacteriophage. All studies were carried out with an RCA Type EMU 2 microscope. Ruptured bacteria are common from cultures chilled immediately after mixing. In photographs such as that of Fig. 1, their protoplasm can be seen flowing out and engulfing the infecting particles. Foci of bacteriophage multiplication are apparent as dark clumps in similar cellular residues if incubation has proceeded for a few minutes before chilling. These foci, seemingly developed from the infecting particles, are at first few in number (Fig. 2). They are more numerous after longer incubation and after about 15 min. separate, presumably; newly formed particles are also seen distributed throughout the remains of the bacterial protoplasm. Both clumps and single particles increase still further with incubation, and eventually the regions of lysed protoplasm are more or less completely covered by the bacteriophage particles that have, through their growth, used up most of the protoplasm. As Fig. 2 suggests, detail cannot usually be discerned in the opaque clumps. Where, however, protoplasm has been washed or eaten away, they can be seen to consist of groups of particles (Fig. 3). These particles are commonly smaller than the average and are associated together in ways that suggest developing forms. Many of the free particles seen after short periods of incubation resemble the particles of these groups and, like them, are small.

Information from such electron micrographs, of which several hundred have now been obtained, indicates that these bacteriophage particles increase in number at the expense of bacterial protoplasm by a process that in many ways resembles the multiplication[2] of coccoid bacteria. Apparently most of this growth and multiplication takes place in the protoplasmic masses liberated by lysis rather than in bacteria which are still intact. In these respects bacteriophage can be thought of as a parasite living on bacterial protoplasm. It has been, and will continue to be, difficult to observe many details of this multiplication, because it necessarily occurs within masses of bacterial protoplasm the molecular texture[3] of which is not much finer than that of the developing bacteriophage.

Particles of bacteriophage resemble micro-organisms in other ways. Thus they have a complex organisation that includes a flagellar appendage and a head consisting of particles enclosed in a well-defined membrane. The amino-acid composition of bacteriophage protein is significantly different from that of its host[4]. Additional evidence about the 'living' nature of bacteriophage can be obtained from studies of its rate of diffusion. A number of years ago Northrop[5] found that a sufficiently dilute staphylococcus bacteriophage suspension seemed to diffuse faster than would be expected from its particle size. Recent measurements by Polson and Shepard[6] in this Laboratory, by a different method, have indicated that dilute coli bacteriophages also diffuse abnormally rapidly. The new data, however, are not entirely satisfied by Northrop's assumption of dissociation into small active fragments, and it is conceivable that they point to an independence of particle movement

Fig. 1

Fig. 2

Fig. 3

Fig. 1. A colon bacillus being lysed under the action of *T* (2) bacteriophage. Granular protoplasm flowing from the lower part of the organism has partly engulfed a bacteriophage particle at the left. (× *c.* 17,000)

Fig. 2. Protoplasm from part of a lysed colon bacillus showing three opaque centres of multiplication. (× *c.* 17,000)

Fig. 3. Two clumps of developing bacteriophage particles free of enveloping protoplasm. The several developing particles in the lower clump and the single mature particle to the right of the upper clump are essentially clear. (× *c.* 40,000)

that presumably would be sustained by some kind of metabolic activity.

Bacteriophages are known which have diameters as small as c. 100 A. If they multiply in the autonomous fashion observed for the *T*(2) bacteriophage, then 'living' self-reproducing objects exist which are considerably smaller than the molecules of such well-defined proteins as the haemocyanins and erythrocruorins.

These studies are being described in more detail in papers appearing in the *Biochimica et Biophysica Acta*.

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Ultra-Violet Microscopy of Living Malignant Cells

PREVIOUS work on the ultra-violet microscopy of living cells has led to conflicting conclusions as to the value of this technique in cytological research. Thus, Wyckoff, Ebeling and Ter Louw[1] reported that Feulgen staining, which demonstrates desoxyribose-nucleic acid in fixed cells, duplicates the results obtained by the ultra-violet microscopy of living cells. "Ultra-violet microscopy can be considered as the equivalent of a vital staining specific for formed chromatin" was their conclusion. More recently, in *Nature*, Brumberg and Larionow[2] maintained that desoxyribose-nucleic acid is present in the nucleus of living cells in a form which does not absorb irradiation in the 2600 A. region, and that absorption only occurs in injured and dead cells.

We have explored the possibility of investigating living cells by ultra-violet microscopy and have utilized for the purpose several strains of rapidly growing malignant cells which have been maintained for some years by serial transplantation in inbred strains of mice at the laboratories of the Imperial Cancer Research Fund (Ludford and Barlow[3,4]). Fibroblasts from subcutaneous connective tissue and mesothelial cells have also been included in the study. The apparatus used was that designed by Barnard, and the technique employed the same as described by him and Welch[5,6]. It has the considerable advantage in that dark-ground illumination with visual light is employed for selecting objects for ultra-violet micrography. By this procedure cells receive the minimum exposure to ultra-violet irradiation—only the few seconds during exposure of the photographic plate. A preliminary study of the cells was made by phase-contrast photomicrography so as to establish a standard for comparison with ultra-violet micrographs, in order to be able to detect any indication of cellular injury that might be revealed in the latter. It was found possible to obtain pictures of living cells by employing objectives computed for working with wave-lengths of 2570 A. and 2750 A., without any appreciable injury to cell structure. Microspectrographic analysis of living cells as carried out by Caspersson[7] with fixed tissues was not possible. Living cells would not tolerate the necessary series of exposures to irradiations of different wave-lengths. For reasons adduced by Caspersson, we have therefore assumed, without unequivocal evidence, that structures exhibiting strong absorption in micrographs taken with wave-lengths of 2570 A. and 2750 A. are of a nucleotide nature.

Numerous observations in cytopathology point to the mitochondria as sensitive indicators of cell injury. They react rapidly to ultra-violet irradiation. They first become distorted and then disintegrate, leaving vacuoles in the cytoplasm. In the sarcoma cell shown in Fig. 1 (2750 A.) are seen well-defined filamentous mitochondria characteristic of actively growing cells. The nucleus of this cell contains several large nucleolar masses with the "nucleolar associated chromatin" of Caspersson[8]. The cytoplasm contains a considerable amount of absorbing substance, which has been a conspicuous feature of all our rapidly growing malignant cells. A very pronounced change in the distribution of nucleotides takes place during cell division. About the time the nuclear membrane breaks down at prophase the mitochondria become rounded and are seen to bear peripheral deposits of nucleotides. Much smaller granules, most of which are below the limits of resolution (probably the microsomes of Claude[9]), are distinguishable among the much larger rounded mitochondria. The 'ground cytoplasm' is almost completely depleted of absorbing substance; but the chromosomes exhibit strong absorption throughout mitosis. These features are apparent in the sarcoma cell at telophase seen in Fig. 2 (2570 A.). Towards the end of the cleavage process the mitochondria become filamentous again,

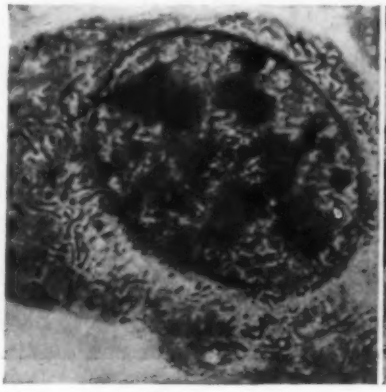

Fig. 1

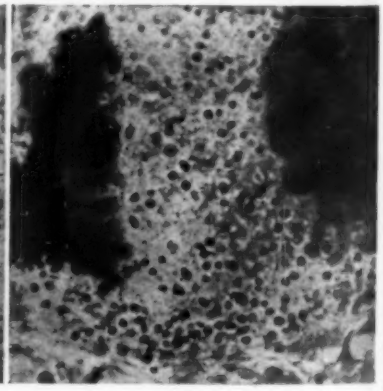

Fig. 2

Fig. 1. Living sarcoma cell with numerous filamentous mitochondria characteristic of active growth. From tumour *Rb* of the Imperial Cancer Research Fund. 2750 A.
Fig. 2. Dividing sarcoma cell from the same tumour as Fig. 1, showing the changed form of the mitochondria and altered distribution of nucleotides during mitosis. 2570 A.

and at the same time nucleotides reappear in the cytoplasm even though the chromosomes are still clearly distinguishable in the reconstituting nuclei, and no nucleoli have been reformed. In none of our micrographs of recently divided cells is there any suggestion of a greater concentration of absorbing substance directly surrounding the nuclear membrane which might imply a nuclear origin of cytoplasmic nucleoproteins. On the contrary, the nucleus is often surrounded by a relatively clear area. Our observations implicate the mitochondria rather than the nucleolus in cytoplasmic nucleoprotein synthesis.

Ultra-violet microscopy affords unique opportunities for studying the internal structure of the living nucleus. Some micrographs of dividing cells at late anaphase show the chromosomes already divided longitudinally, and this double thread-like structure persists in the 'resting' nucleus. Under appropriate conditions, nuclei can be seen to be composed of attenuated double threads upon which are disposed parallel pairs of minute granules that are not properly resolved with a wave-length of 2570 A. These would seem to be chromomeres or possibly gene loci.

Comparison of micrographs of fibroblasts from connective tissue with malignant fibroblasts (sarcoma cells) reveals a definite correlation between the amount of nucleotides and the rate of cell-growth. Particularly striking is the intense cytoplasmic absorption of rapidly growing sarcoma cells in comparison with the relatively clear cytoplasm of 'resting' fibroblasts.

Additional ultra-violet micrographs illustrating the various observations reported here will be published in subsequent communications.

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Cytochemistry of the Gonadotropic Hormones

Describing the histological demonstration of mucin after periodic acid, McManus[1] states that a positive reaction is given, *inter alia*, by "certain pituitary cells" and "the colloid of the pituitary stalk". According to Chow[2], the follicle-stimulating and luteinizing fractions of the anterior pituitary secretion are glycoproteins, and Evans *et al.*[3] confirm that the former contains 10·3–13·1 per cent carbohydrate and 8 per cent glucosamine. According to K. Meyer's classification, it is thus a mucoprotein, that is, it contains more than 4 per cent hexosamine. Furthermore, Gurin[4] has shown that chorionic gonadotropin is also a mucoprotein, containing galactose (10–12 per cent) and hexosamine (5–6 per cent) as an integral part of its molecule, and Gey *et al.*[5] have demonstrated the production of this hormone by cytotrophoblast cells in tissue culture. On the contrary, Fraenkel-Conrat *et al.*[6] have shown that the growth-hormone fraction of the pituitary contains only 0·25 per cent sugar and less than 0·9 per cent glucosamine.

The technique I have used is that described by Hotchkiss[7], which is essentially like McManus' and gives positive results with a wide variety of carbohydrate substances; but of these, after ordinary aqueous fixatives, only mucopolysaccharides, mucoproteins, glycoproteins and traces of glycogen remain. If it is true that the gonadotropic hormones are produced by the basiphil cells of the pituitary, these should be stained by the McManus–Feulgen technique, with the acidophils remaining colourless.

This has been found to be the case. The colloid of the stalk, the colloid of the acini and the granules of the basiphils are stained positively. In addition, a variable proportion of the chromophobes contain vesicles and granules which are stained bright red, and these are occasionally present in mature basiphils. It is concluded (*a*) that the secretion of the basiphils is the gonadotropic hormone, and (*b*) that some chromophobes are, as Severinghaus[8] has postulated, predestined basiphils.

Similar granules are found in the Langhans' cells of the chorionic villi and of chorion epithelioma. It is suggested that these granules may be the chorionic gonadotropin.

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Relative X-Ray Sensitivity of Metaphase and Interphase Chromosomes

Many investigators have studied the problem of radio-sensitivity of cells in different stages of mitosis and meiosis in a wide range of plants and animals. Much disagreement still exists, however, as to which stages of the nuclear cycle are stages of high sensitivity to chromosome breakage and which stages are relatively resistant.

It is generally acknowledged that radio-sensitivity varies inversely with the degree of tissue differentiation, and that the change in sensitivity during differentiation is relatively high. However, it is not generally realized that the extent of sensitivity changes which may occur within a single cell-generation is also very high. A preliminary report is given here of the range of sensitivity of chromosomes to X-ray breakage during microsporogenesis in *Trillium erectum*.

Rhizomes of *Trillium erectum* were stored at 4–6° C. for several weeks before irradiation. Shortly before treatment a test slide was made from one or more anthers from each flower bud to determine the stage of division. Due to the high degree of synchronization of meiotic divisions, it may be assumed that the remaining anthers contained mostly microsporocytes in a similar stage. After

exposure to 160 kV. X-rays, the plants were again placed in cold storage until microspore division, and then smears were taken.

Sensitivity was determined by counting the number of fragments present at microspore metaphase following irradiation with 50 r. at either first meiotic metaphase or early post-meiotic interphase. Examination of first or second anaphases after irradiation at first metaphase revealed very few fragments or bridges. However, after such cells had passed through post-meiotic interphase, a high degree of fragmentation was evident. (In *Trillium erectum* there is no regular interphase between first and second meiotic divisions. The chromosomes go from first anaphase directly into second metaphase without the usual resting period.)

Average number of fragments scored at microspore metaphase after a dose of 50 r. at first metaphase and at early post-meiotic interphase in *Trillium erectum*

Number of plants irradiated	Stage irradiated	Number of microspores scored	Average number of fragments per 100 pollen mother-cells
7	Metaphase I	2300	556
4	Early post-meiotic interphase	735	11·2

The average number of fragments per 100 microsporocytes (or per 400 microspores) is given in the accompanying table. The data show first metaphase to be a stage of high sensitivity to X-ray breakage, and early interphase a stage of very low sensitivity. Treatment at metaphase produced approximately fifty times as many fragments as the same dosage at early interphase. Since these two stages do not necessarily represent the stages of highest and lowest sensitivity, it is considered that a fifty-fold increase is a conservative estimate of the actual sensitivity change which occurs during the nuclear cycle. This range is considerably higher than that previously reported[1,2] for *Trillium*, mainly because the interphase had not been sufficiently studied to establish the point of lowest sensitivity. A comparable order of change has been reported by Conger[3], who found metaphase to be approximately thirty-seven times as sensitive as resting nuclei in onion root-tip cells. Failure to examine for aberrations in the succeeding divisions may be responsible for previous claims[4–6] that metaphase chromosomes are not damaged by X-rays. It should also be pointed out that measurements of sensitivity based on the percentage of rejoining of broken ends do not agree with a sensitivity value based on fragmentation only[7]. This also may have contributed to conflicting claims[8] as to stages of high *versus* low radio-sensitivity.

This investigation was begun in the Biological Laboratories of Harvard University. Financial assistance was received from the American Cancer Society and from the Cancer Research Division of the Donnor Foundation.

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Production of *i*-Erythritol by *Aspergillus niger*

CERTAIN strains of *A. niger*, as is well known, ferment sugar to citric acid to the virtual exclusion of any other acid. Strong citric acid fermentations, however, are often accompanied by the production of mould starch[1] and a dextrin-like substance[2]. The present communication directs attention to the formation also of *i*-erythritol. Though this tetrahydric alcohol has already been found in two species of *Penicillium*, namely, *P. brevi-compactum* Dierckx and *P. cyclopium* Westling[3], and in one species of *Aspergillus*, *A. terreus*[4], rather surprisingly no one has hitherto reported its occurrence in cultures of *A. niger*.

The citric acid of the fermented solution and washings from the mould mycelium is first precipitated as the calcium salt and removed by filtration. The filtrate, which may contain some residual reducing sugar in addition to the starch and dextrin, is concentrated by evaporation. During this operation, most of the calcium citrate still in solution is thrown out and is filtered off. The filtrate is treated with two or three volumes of alcohol and the precipitate which forms is removed. The alcohol is evaporated off and the syrup remaining crystallizes on standing. The crude crystals are separated and purified by treatment with decolorizing carbon and recrystallization.

The aqueous solution of these crystals is neutral, shows no optical activity and does not reduce Fehling's solution. It has a sweet taste. Solubility in water rises rapidly with increasing temperature.

The crystalline substance gave m.p. 119·5–120·5° C.; mixed with a sample of authentic *i*-erythritol, m.p. was 119–120° C. Analysis: found (Weiler): C, 39·57; H, 8·24 per cent; calculated for $C_4H_{10}O_4$: C, 39·34; H, 8·25 per cent. The acetyl derivative had m.p. 85–86° C.

I desire to acknowledge the assistance of two colleagues, Mr. G. H. Gossop and Mr. L. G. Manchester, in the work here reported.

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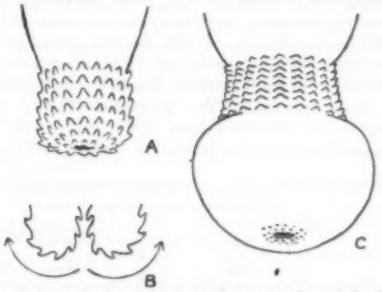
Thixotropy, and the Mechanics of Burrowing in the Lugworm (*Arenicola marina* L.)

Chapman and Newell[1] have recently published the following argument:

(1) Lugworms can burrow into a particular beach whether covered by sea-water or not. The total downward thrust which a worm can exert is limited by its weight. If one divides the immersed weight of a worm by the area of its front end, one finds "that the maximum pressure which can theoretically be exerted cannot exceed 16 g./sq. cm.". (2) A man can walk across the same beach without sinking in, though his feet exert a pressure of about 150 gm./sq. cm. (3) "The explanation of this apparent anomaly must be sought in the physical properties of the wet sand." The authors demonstrate that the sand is thixotropic by "stepping five times with the weight of the body on the foot"; this causes the

sand to liquefy, after which it fairly rapidly sets again. They suggest that "when a worm begins to burrow in the sand, its resistance is first reduced by alternating extrusion and withdrawal of the proboscis and then the anterior end of the worm is thrust into the softened sand".

It will be noted that the demonstration of thixotropy was made by using pressures considerably greater than those the lugworm can produce. But, in any event, I am unable to see any real contradiction between the first two observations, and do not believe that it is necessary to invoke thixotropy at all.



Action of the proboscis. *A*, Incomplete extrusion of the buccal mass. *B*, Section through the advancing buccal mass. *C*, Extrusion of the pharynx

As the worm burrows, it repeatedly extrudes and withdraws its proboscis. This proboscis consists of two main parts. The first part to emerge is the buccal mass, which is set with strong, conical teeth, directed as shown in the diagram (*A*). As it comes out, the thrust on the sand will first be sideways to the line of advance, then backwards towards the animal's tail, as shown by the arrows in (*B*). The latter (backwards) thrust is assisted by 'flanging' movements of the more anterior chætigerous annuli[3], which occur during burrowing. If one causes a worm to burrow into an artificial sand consisting of very small glass spheres (Messrs. Chance Bros.' 'Ballotini') —which it can and sometimes will do—then these movements of the chætigerous annuli may be seen.

After its extrusion, the buccal mass shortens considerably as the second part of the proboscis, the pharynx, is violently thrown out (*C*). The pharynx is a soft balloon, with numerous very small papillæ. Its ejection rather suggests the sudden blowing of a bubble by the worm. It may serve to drive out the sand from the hole rasped by the buccal mass, and perhaps to shape it.

The front end of the worm narrows and lengthens as the buccal mass is extruded, as if to drive it further into the sand. In the second stage, when the buccal mass shortens and widens, the front end of the worm does so too; so the pharynx is thrust out more or less into the area already worked upon by the buccal mass.

These facts show that the lugworm is not at all comparable to a body sinking into the sand under its own weight. It is more like a digging rabbit, which scratches and shovels the earth away. The actual disruption of the structure of the sand must be done by the teeth of the emerging buccal mass. Unhappily, it is not easy to assess the force with which the worm could make them diverge from each other. Chapman and Newell[1] give a number of valuable data on the hydrostatic pressure in the body cavity under various conditions; they recorded pressures up to 27 cm. of sea-water in worms "actually engaged in burrowing". But other factors play a part; if one transects a worm immediately behind the first chætigerous annulus, the very small front end so isolated can still extrude and withdraw its buccal mass, though it seems unable to throw out its pharynx.

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Some Geometrical Considerations Regarding Imbricate Æstivation

In connexion with some anatomical investigations now in progress, an occasion has arisen for reviewing the evidence for a possible affinity between the Ranales and the monocotyledons. A critical consideration of certain floral features reveals that a number of phenomena on which considerable stress has been placed are not, in fact, independent results, but may be deduced as geometrically inevitable consequences of the nature of imbricate æstivation.

Imbricate æstivation may be defined as the arrangement of flattened organs in a ring so that each edge of each member of the ring overlaps with one of the edges of an adjacent member. It will be convenient to distinguish three types of member: external, with both edges outside those with which they overlap; internal, with both edges inside; and oblique, with one edge inside and one edge outside. Let the numbers of members in each category be denoted by e, i and o respectively. Then the total number of outside edges is $2e + o$ and the total number of inside edges is $2i + o$. But, from the nature of imbricate æstivation, there are as many outside edges in a ring as inside ones, so that $2e + o = 2i + o$ and $e = i$. There follow two important corollaries: first, the number of oblique members is odd or even according as the total number of members in the ring is odd or even; secondly, a ring with an odd number of members must have at least one oblique member.

Now suppose that a ring is being built up by placing members in position one at a time. If the first member is to be external, the one next to it cannot be external. It can be either internal or oblique. If it is oblique its free edge (that is, the one farthest from the first member) will be an outside edge. The third member can then be either internal or oblique, but not external. Obviously, it is impossible, moving round the ring from an external member, to reach another external member without first passing an internal one. A similar train of argument can be used to prove the converse. We have therefore established the proposition that: the internal and external members of any ring of imbricating organs will occur in equal numbers and will alternate regularly all round the circumference.

In other words, any ring of imbricating organs may be regarded as consisting of two equal alternating whorls, with the addition of a varying number of oblique members which do not belong definitely to either whorl, and which may be distributed in various ways. The appearance of two independent alternating whorls can be regarded as the special case arising when o is zero, and contort æstivation as that arising when e and i are zero.

Consider a ring of organs in which the position of any edge (that is, whether inside or outside) is independent of the position of the other edge of the same member. Clearly, it is to be expected that, of the total number of members present, one quarter will be external, half oblique and the remaining quarter internal.

It is interesting to reconsider some of the observed facts in the light of these theoretical results. The commonest number of petals in *Ficaria verna* is eight, as stated by Salisbury[1]. In most cases this number is made up of three internal petals, three external and two oblique. Obviously the position of one edge of a petal markedly influences that of the other edge; conditions are unfavourable for the production of oblique members. Salisbury concluded that the corolla was derived from one with two alternating trimerous whorls, the oblique members having arisen by division of the members of these whorls. But it is not difficult to find flowers in which the 'whorls' are dimerous, while in flowers with more than eight petals there are often four external and four internal petals.

Hitherto, it has not been sufficiently appreciated that any condition unfavourable to the production of oblique members automatically brings about the appearance of alternating whorls. In *Ficaria* the elimination of oblique members is incomplete, but has gone far enough to give, in most flowers, an appearance of alternating trimerous whorls.

It has been shown that complete elimination of oblique members is not possible when the total number of organs is odd. The pentamerous plan does not permit elimination of oblique members beyond the condition seen in the familiar quincuncial arrangement. The observation (ref. 1, p. 54) that, in plants with variable numbers a hexamerous calyx or corolla may consist of two trimerous whorls while a pentamerous one is quincuncial, is therefore only to be expected, and does not justify the conclusion that the oblique member in the quincuncial arrangement is the result of the fusion of one external member with one of the internal ones.

It is not my purpose to belittle the significance of evidences of trimery in the Ranalean flower, or to deny the conclusions reached by Salisbury and others as to increase or decrease in the number of floral parts, but merely to point out that peculiarities of æstivation are often only expressions of geometrical necessity, and are therefore not available as evidence for determining the course of floral evolution.

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Initiation of Explosions by Grit Particles

Earlier work[1,2] has shown that the initiation of liquid and solid explosives by impact or friction is due to the formation of localized hot spots. These hot spots may be generated by adiabatic compression of small entrapped bubbles, by friction and shear at solid surfaces, and, in extreme cases, by the viscous heating of rapidly flowing explosive. It was found that for nitroglycerine the minimum temperature of the momentary hot spot necessary for initiation by friction was *c.* 400–500° C.

It is known that explosives are made more sensitive both to impact[3] and to friction[1] if small particles of grit are mixed with them. The early work showed that the rise in the surface temperature of a solid under friction is usually limited by its melting point. If initiation is due to the development of hot spots on the grit particles, we should therefore expect that the effectiveness of a particle would depend on its melting point. Some experiments have been carried out to investigate this.

A few small solid particles of known melting point were added to the solid explosive, which was spread as a thin layer between flat steel surfaces. In one series of experiments the explosive was then subjected to rapid shear, while in another series it was subjected to an impact just strong enough to give very occasional explosions (*c.* 2 per cent) in the absence of any grit. Over the range used the hardness of the particle was relatively unimportant, but its effectiveness in initiating an explosion depended on its melting point.

Initiation of P.E.T.N. in the presence of foreign particles

'Grit' added	Hardness (Moh scale)	Melting point (° C.)	Explosion efficiency % (friction)	Explosion efficiency % (Impact)
No grit	—	—	0	2
Ammonium nitrate	2–3	169·6	0	~2·5
Potassium hydrogen sulphate	3	210	0	~2·5
Silver nitrate	2–3	212	0	2
Sodium dichromate	2–3	320	0	0
Sodium acetate	1·5	324	0	0
Potassium nitrate	2–3	334	0	0
Potassium dichromate	2–3	398	0	0
Silver bromide	2–3	434	50	6
Lead chloride	2–3	501	60	27
Silver iodide	2–3	550	100	—
Borax	3–4	560	100	30
Bismuthinite	2–2·5	685	100	42
Glass	7	800	100	100
Chalcocite	3–3·5	1100	100	50
Galena	2·5–2·7	1114	100	60
Calcite	3	1339	100	43

The hardness of P.E.T.N. is *c.* 1·8 and its melting point 141° C.

The friction experiments gave the results with P.E.T.N. shown in the fourth column of the accompanying table. All the substances melting above 430° C. were effective in initiating this explosive, while all those melting below 400° C. had no effect. Similar results were obtained for the frictional initiation of lead azide, but in this case the limiting temperature was somewhat higher. Silver iodide melting at 550° C. and all substances of higher melting point were effective, but lead chloride, melting point 501° C., and lower melting solids were not.

The last column of the table shows the impact sensitivity of P.E.T.N. under similar conditions, and again it will be seen that only substances melting above 430° C. were effective. Impact experiments on lead styphnate and mercury fulminate gave similar results, but the limiting melting point was about 500° C.

High-speed camera studies confirm that initiation occurs at the grit particle, and that the first stage of propagation is usually a slow burning[4]. These simple experiments indicate that the initiation of explosives containing grit is due to the formation of hot spots on the grit particle. Under the conditions of these experiments, the minimum effective hot-spot temperature for the explosives studied was again about 400–500° C.

We thank the Ministry of Supply (Air) and the Royal Society for grants for equipment, and Imperial Chemical Industries, Ltd. (Explosives Division), for the research maintenance of one of us (O. A. G.).

Note added in proof (*October* 8). Recently, Ubbelohde *et al.*[6] have published results on the effect of grit. Under the conditions of their experiments they did not observe an increase in sensitivity unless the hardness of the grit exceeded 4 on the Moh scale. They find supporting evidence for hot spot initiation in that the sensitivity with hard grit particles is influenced by the melting point of the anvil.

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Dielectric Properties of Mixed Barium and Strontium Titanates at 10,000 Mc./s.

Measurements have been made of the complex permittivity $(\varkappa' - j\varkappa'')$ of a series of mixed barium and strontium titanates at 9,450 Mc./s. and 20° C. by a technique, already described[1,2], which employs a wave-guide containing a multilayer dielectric slab.

The variation of $\varkappa'$ and $\tan\delta\ (= \varkappa''/\varkappa')$ at 9,450 Mc./s. is shown in Fig. 1, and also that of $\varkappa'$ at 1·5 Mc./s., for purposes of comparison. The value of $\tan\delta$ at 1·5 Mc./s. is of the order 0·01 throughout.

It is well known that the addition of strontium titanate to barium titanate lowers the temperature of the Curie point by an amount proportional to the percentage of strontium[3]. The Curie point occurs at 20° C. for the composition 72 per cent $BaTiO_3$, 28 per cent $SrTiO_3$. The marked variation in permittivity which occurs at 1·5 Mc./s. for 72 per cent $BaTiO_3$ is considerably modified at 9,450 Mc./s. and results for the compositions 66 and 75 per cent $BaTiO_3$, lying closely on either side of this point, suggest that there is no great perturbation in the dielectric properties, although this has not been closely investigated. The dispersion in permittivity suddenly becomes appreciable, and the loss tangent rises rapidly for concentrations of barium titanate well below that at which the material becomes permanently polarized.

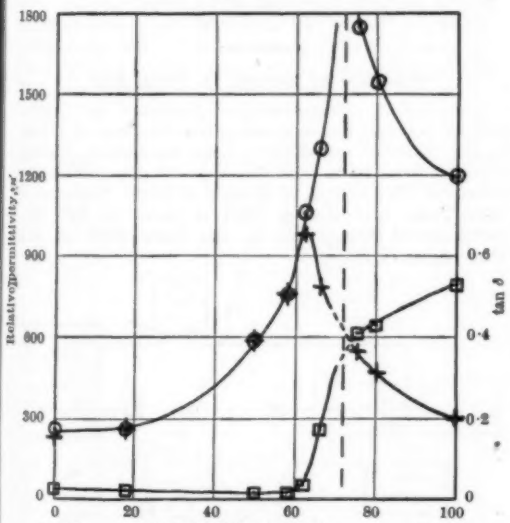

Fig. 1. Barium–strontium titanate mixtures at 20° C. ○, $\varkappa'$ at 1·5 Mc./sec.; +, $\varkappa'$ at 9,450 Mc./sec.; □, $\tan\delta$ at 9,450 Mc./sec.

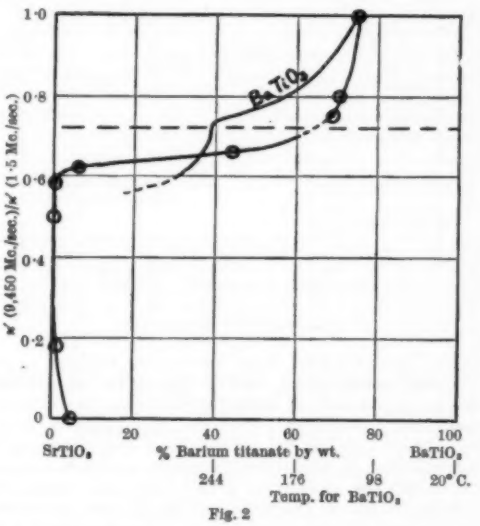

Fig. 2

An alternative way of showing the dispersion is to plot $\dfrac{\varkappa' \text{ (at 9,450 Mc./s.)}}{\varkappa' \text{(at 1·5 Mc./s.)}}$ versus composition as in Fig. 2.

On the same figure is plotted the result for barium titanate alone, at variable temperature[3], where the temperature scale is related to the composition of the mixed titanate by the shift in the Curie point mentioned above. The essential similarity of the two curves may be noted, and also the fact that in both cases the dispersion is closely associated with the permanently polarized condition.

Incidentally, the material with composition 56 per cent $BaTiO_3$, 44 per cent $SrTiO_3$, having $\varkappa' = 760$ and $\tan\delta = 0{\cdot}02$ at 9,450 Mc./s. and 20° C. should be of considerable technical importance in microwave work. The maximum permittivity value observed was 990 with $\tan\delta = 0{\cdot}04$ at a composition of 62 per cent $BaTiO_3$, 38 per cent $SrTiO_3$.

I wish to thank Mr. Popper, of Philips Electrical, Ltd., for providing suitable ceramic materials.

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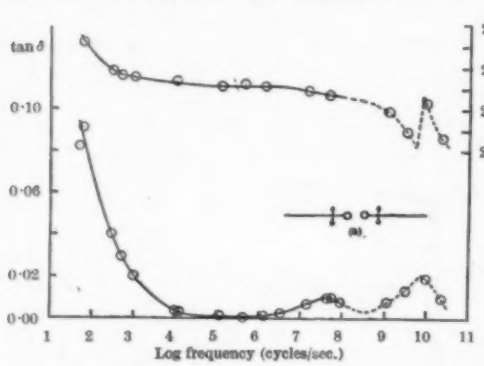
Dielectric Behaviour of Methyl Palmitate : Evidence of Resonance Absorption

THE complex permittivity $\varkappa = \varkappa' - j\varkappa''$ of methyl palmitate, $C_{15}H_{31}COO.CH_3$ (melting point (sharp) 29·7° C.), has been determined at room temperature (17–20° C.) over the frequency-range $50–3 \times 10^{10}$ cycles/sec., with the results shown in the diagram, in which $\varkappa''$ is presented in terms of the tangent of the dielectric loss angle, $\tan\delta = \varkappa''/\varkappa'$. The $50–10^4$ c./s. measurements were made on a Schering bridge ; the $10^4–10^8$ c./s. ones by a reactance variation resonance method[1], and the higher-frequency measurements by use of a number of cavity resonators[2].



The results reveal three absorption regions in the spectrum investigated, and in seeking an explanation of the mechanism of these the following possibilities must be considered : normal (D.C.) conduction ; anomalous conduction arising from the presence of aggregations of conducting impurity ; dipole relaxation ; and the occurrence in this frequency-range of a natural vibration frequency of the dipolar molecules or of parts of these molecules. The measured D.C. conductivity was found to account for no more than 1 per cent of the low-frequency value of tan δ, and the material tested was of such purity as to exclude the second possibility. In connexion with the third, if there exist two positions of equilibrium corresponding to opposite dipole directions with a transition probability of p per sec., then energy absorption will occur around the frequency $p/2\pi$ c./s. With methyl palmitate there appear to be two such possibilities, involving rotation of the molecule about its axis and about an axis perpendicular to this. Since the probability of the latter type of rotation would seem to be small, the absorption between 50 and 10^3 c./s. may perhaps be accounted for on this basis. Unfortunately, in the absence of measurements at still lower frequency, the peak of this absorption is undetermined ; but there is reasonable correlation between the observed changes of $\varkappa'$ and tan δ in this region, and they indicate an effective resolved component of dipole moment of the order of 1·3 Debye units.

On this basis the second absorption is presumably due to a rotation of the molecule about its axis, though, since it has been concluded by Malkin[3] from X-ray studies that methyl esters crystallize as double (end-on) molecules, the moving unit may be the double molecule. It can be estimated from the variation of tan δ in the region of this second absorption that $\varkappa'$ should decrease by 0·06, which is consistent with the observed variation of $\varkappa'$, and suggests an effective resolved part of the dipole moment, in this case, of about 0·4 Debye units.

The variation of $\varkappa'$ associated with the third, ultra high-frequency, absorption region would seem to identify this as a resonance phenomenon ; although, if a curve be drawn through the four available experimental points, this variation appears as the inverse with respect to frequency of what is to be expected. This suggests that the four points at which measurements have thus far been made are inadequate to afford full resolution of the dispersion and absorption, and measurements at additional frequencies and at low temperatures are essential for clarification.

A resonance absorption in solids in the electrical spectrum has not previously been reported ; but the prospect of this occurrence with compounds of the type under consideration within the 1/10 to 1/100 cm. wave-length band $(3 \times 10^{11} – 3 \times 10^{12}$ c./s.) has been predicted by Fröhlich[4]. The evidence that methyl esters crystallize in double molecules suggests, as one possibility, that the resonance may be due to oscillation of the component single molecules about an axis perpendicular to their length, in the manner indicated at (*a*) in the diagram. If this be so, the frequency of vibration would presumably be lower than for the type of oscillation discussed by Fröhlich.

It is desired to emphasize the tentative nature of the explanations suggested above pending the completion of further work now in progress.

Our thanks are due to Dr. L. Hartshorn, of the National Physical Laboratory, for help in connexion with the low-frequency measurements, and of one of us for a studentship provided by the Australian Council for Scientific and Industrial Research.

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Velocity of Sound in Free Air

A PREVIOUS communication[1] described an oscillographic method for measuring the velocity of sound in air. Further experiments have been made during the past four years, with the aid of a grant from the Research Committee of King's College, Newcastle-upon-Tyne, and during 1947 a series of 940 determinations was made in the Bute Hall of the University of Glasgow.

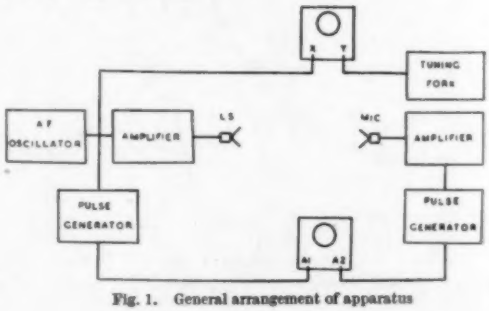

Fig. 1. General arrangement of apparatus

The object of these experiments was to measure the velocity of sound in free air with an accuracy of the same order as that which has been achieved in the best supersonic measurements. The general arrangement of the apparatus is shown in Fig. 1. Sound, at 13,500 c./s., was emitted by a small moving-coil loud speaker connected through an amplifier to an audio-frequency oscillator, and was detected by a receiver, consisting of another loud speaker, identical with the first, mounted on a screw mechanism, permitting it to be moved relative to the source, along the line joining their centres. The output from the receiver was amplified and passed to a pulse-generating circuit, which delivered a train of pulses, each about a microsecond in duration. These pulses were used to deflect one beam of a double-beam oscillograph, which had an internal time-base, synchronized by the audio-frequency oscillator output.

If the microphone was moved relative to the source, the pulses travelled across the screen, and the distance between two successive positions of the microphone at which a pulse coincided with an arbitrary reference mark on the screen was equal to the wave-length of the sound. The reference mark was obtained by connecting the audio-frequency oscillator to a pulse-generating circuit, and applying the resulting pulses to the other beam of the oscillograph.

At a frequency of 13,500 c./s., the wave-length of sound at normal temperatures is about one inch. The screw was six feet long and was fitted with a scale calibrated in thousandths of an inch. By moving the microphone, simultaneously observing the oscillograph screen through a telescope, and counting the transits of the receiver pulses, a length equal to 40 wave-lengths was measured 940 times, under varying atmospheric conditions. The frequency of the oscillator was checked continuously against that of a 1,000 c./s. valve-maintained tuning fork (which had an accuracy of a few parts in a million), using a Lissajous figure on the screen of a subsidiary oscillograph; after the apparatus had been operating continuously for a fortnight, the frequency drift was very small and could easily be corrected. The temperature was found by observation (through a telescope several yards away) of two mercury thermometers suspended between the source and the receiver. The humidity of the air was found from readings with a whirling hygrometer, and the carbon dioxide content was measured with a Haldane carbon dioxide apparatus. The room in which the experiments were conducted was 115 ft. long, 69 ft. wide and 67 ft. high; it was empty of furniture and was free from serious draughts. The apparatus was placed in the centre of the room, well clear of the floor, and no reflexions from walls or ceiling were detected.

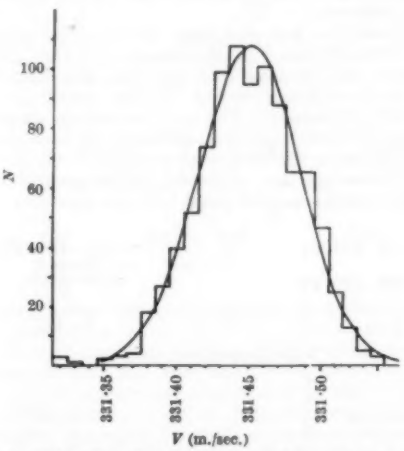

Fig. 2. Distribution of the 940 results, with normal error curve superimposed

Corrections were applied to the results for the influence of the following factors: (1) temperature, which affects (*a*) the density, (*b*) the specific heat C_v, and (*c*) the imperfection of the air; (2) presence of water vapour, which affects (*a*) the density and (*b*) the specific heat C_v of the air; (3) the known error of the screw and the thermometer.

The mean value found for the velocity of sound at a frequency of 13,500 c./s. in dry air at temperature 273·16° K. and pressure 1013·2 mb., containing 0·03 per cent of carbon dioxide, was 331·45 ± 0·04 metres per second. The distribution of the 940 results is shown in Fig. 2, with the normal error curve for the same number of results and the same standard deviation superimposed for comparison.

A fuller account of this work is being prepared for publication elsewhere.

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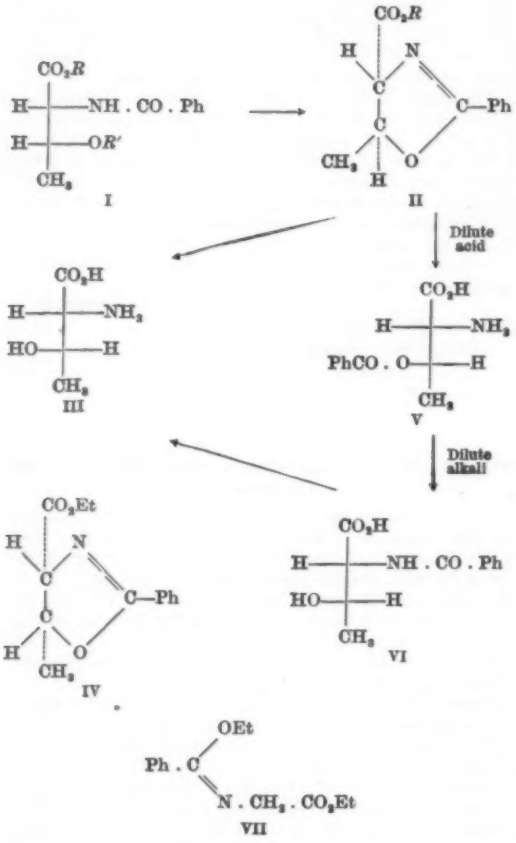
Studies in the Synthesis and Isolation of Threonine

In a communication to the editor of the *Journal of the American Chemical Society*[1] which has just been received are described the conversion of DL-N-benzoyl*allo*threonine methyl ester (I, R = Me; R' = H) into the corresponding oxazoline (II, R=Me) by the action of thionyl chloride and hydrolysis of the oxazoline with acid to give DL-threonine (III). This discovery was anticipated by Attenburrow, Elliott and Penny[2], who described not only the thionyl chloride method of inverting the configuration of DL-N-benzoyl*allo*threonine ethyl ester (I, R=Et; R'=H), but also a second and closely related method consisting of the treatment of the *p*-toluenesulphonyl derivative (I, R=Et; R'=Ts) with potassium acetate in boiling alcohol, followed by acid hydrolysis. The same oxazoline (II, R=Et) was produced in both cases, and the view was advanced that inversion of configuration took place simultaneously with ring closure. The *trans* structure was therefore assigned to the oxazoline on the basis of the known configuration of threonine[3].

It has now been found that the reaction of DL-threonine ethyl ester hydrochloride with benzimidoethyl ether constitutes a third method of preparing the oxazoline (II, R=Et). In this type of reaction, which was first applied by Barber *et al.*[4] to ethanolamine, the configuration of the threonine molecule is retained. In a similar way the *cis*-oxazoline (IV), which yielded pure DL-*allo*threonine on acid hydrolysis, was prepared from DL-*allo*threonine ethyl ester hydrochloride. The *cis*-oxazoline, when boiled with aqueous alkali, was rapidly converted into the *trans* form with simultaneous hydrolysis of the ester group. The resulting *trans*-2-phenyl-5-methyl-Δ^2-oxazoline-carboxylic acid (II, R=H) was also obtained by hydrolysis of the *trans*-oxazoline ester (II, R=Et) in

the same way. This interconversion, which must be the result of an equilibrium reaction favourable to the *trans* form, probably occurs via the anion of the oxazoline ester. The *trans* structure was assigned to the carboxylic acid because it was converted successively into DL-O-benzoylthreonine (V) and DL-N-benzoylthreonine (VI) by the action of dilute acid and alkali respectively. It seemed scarcely possible that any configurational changes could occur in these reactions.



As a result of these discoveries, the separation of stereoisomers described in an earlier synthesis of DL-threonine[2] has been rendered unnecessary. Crude DL-ethyl-α-benzamido-β-hydroxybutyrate, an intermediate product in the synthesis, was converted into a mixture of the oxazolines II and IV by the action of thionyl chloride and then into pure DL-N-benzoylthreonine by the series of changes already described. The overall yield was about 60 per cent. Details of this work have already been submitted for publication in the *Journal of the Chemical Society*. It follows from these experiments that the interconversion of D- and L-threonine should be readily achieved, and this is being investigated.

The reaction of benzimidoethyl ether with threonine ethyl ester hydrochloride has been used for the isolation of threonine from casein. Commercial casein was hydrolysed with hydrochloric acid, and after removal of the glutamic acid and the basic amino-acids the remaining mixture was esterified and subjected to the action of benzimidoethyl ether. It was known that glycine ethyl ester hydrochloride would be converted into the derivative (VII) by this reaction[3] and also that compounds of this type, when treated with alkali, would be converted into the corresponding acylamino-acids[4]. It was assumed that other monoamino-acids would behave similarly.

The product was hydrolysed with alkali and acidified to *p*H 1. The acid-insoluble N-benzoyl compounds were removed by extraction, leaving in solution only the acid-soluble O-benzoyl derivatives of serine and threonine. These were converted into the N-benzoyl derivatives when the solution was again made alkaline. As was expected from stereochemical considerations, the N-benzoylserine was racemic. It was separated from the L-N-benzoylthreonine in a pure condition as the sparingly soluble β-phenylethylamine salt. The L-N-benzoylthreonine remaining in the mother liquors as a soluble salt was purified as the free acid by counter-current distribution between ether and water. The yield of L-N-benzoylthreonine was about 10 per cent of that to be expected from the threonine content of the casein hydrolysate.

Experiments are being continued and will be published in full at a later date.

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Aug. 24.

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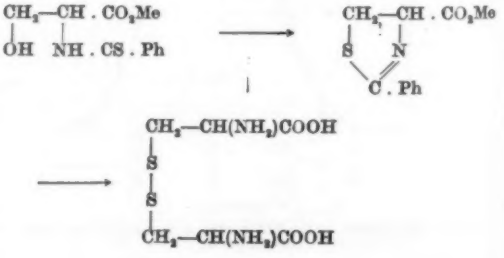
Conversion of DL-Serine into Inactive Cystine

In a previous paper[1] it was shown that DL-N-benzoyl*allo*threonine ethyl ester was converted into the corresponding oxazoline ester with inversion of configuration at the β-carbon atom by the action of thionyl chloride.

This reaction has now been used for the replacement of the hydroxyl group in serine by a thiol group. DL-Serine methyl ester hydrochloride was converted into DL-N-thiobenzoylserine methyl ester by the method of Holmberg[2]. The latter substance, on treatment with thionyl chloride, afforded the corresponding thiazoline in almost quantitative yield. Hydrolysis of the thiazoline and oxidation of the product gave inactive cystine in good yield. Similar reactions have



been carried out on DL-*allo*threonine ethyl ester hydrochloride.

These investigations are being continued.

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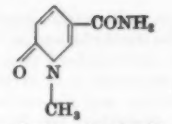
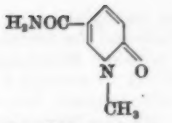
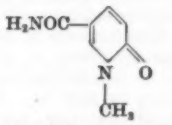
Synthesis of Derivatives of N-Methyl-2-Pyridone from Nicotinic Acid and Nicotinamide

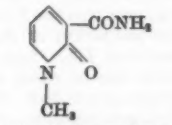
IT is well known that N-methylnicotinamide is formed from nicotinamide by methylation in the human body, and Knox and Grossman[1,2] have shown that N-methylnicotinamide is itself capable of being metabolized. These workers not only demonstrated that N-methylnicotinamide could be oxidized to N-methyl-2-pyridone-5-carboxylamide by an enzyme present in rabbit liver; but they also succeeded in isolating the latter compound from human urine after the ingestion of doses of 0·6–0·9 gm. of nicotinamide per day.

Knox and Grossman described the compound as 1-methyl-3-carboxylamide-6-pyridone, and the corresponding acid as 1-methyl-3-carboxy-6-pyridone. Their nomenclature is similar to that adopted by Beilstein (1-methyl-6-pyridone-3-carboxylic acid), but differs from that used by the earlier workers in this field[3–6], who invariably used the name N-methyl-2-pyridone-5-carboxylic acid.


1-methyl-3-carboxylamide-6-pyridone


N-methyl-2-pyridone-5-carboxylamide

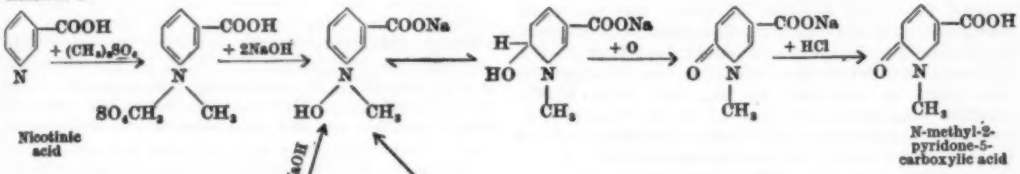

N-methyl-2-pyridone-5-carboxylamide


N-methyl-2-pyridone-3-carboxylamide

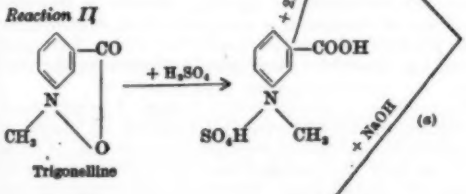
We have studied[7] the reactions which occur *in vitro* when nicotinamide or nicotinic acid is methylated and is then oxidized by the method of Decker[8,9]. It was found that nicotinic acid gave N-methyl-2-pyridone-5-carboxylic acid after methylation and oxidation, but that nicotinamide gave the amide of the isomeric acid, namely, N-methyl-2-pyridone-3-carboxylic acid. These results provided the first evidence that the course of the Decker conversion may be influenced by the nature of the substituent in the 3-position. They also indicated either that the methylation and oxidation of nicotinamide follows a different course *in vitro* from that *in vivo*, or that nicotinamide is converted to nicotinic acid before being methylated and oxidized in the animal body.

After this work was completed, a recent paper of

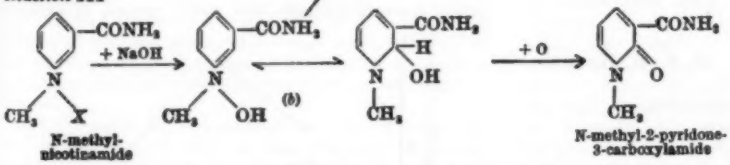
Reaction I



Reaction II



Reaction III



Both names are acceptable, but we prefer to regard the compound as N-methyl-2-pyridone-5-carboxylamide, not only because the earlier workers used this nomenclature, but also because it seems to us to show more clearly the relationship of the compound, from the point of view of chemical structure, to the isomeric N-methyl-2-pyridone-3-carboxylamide (see later). No confusion exists in the literature as to the nomenclature of the latter compound.

Huff[10] came to our notice, in which he described the preparation of N-methyl-2-pyridone-5-carboxylic acid by the oxidation of either trigonelline acid sulphate or N-methylnicotinamide. Since Huff provided no explanation for the reactions which occurred, and since his results might appear to conflict with our findings, it seemed desirable that the position should be clarified. His findings and our own have therefore been combined in the accompanying diagram.

The methylation of nicotinic acid with dimethyl sulphate and the oxidation of the methylation product with alkaline ferricyanide by our method proceeds according to reaction I. The preparation of trigonelline acid sulphate from trigonelline and its oxidation with alkaline ferricyanide, as described by Huff, is shown in reaction II. It is clear that these reactions are very similar. In both cases there is a free carboxylic acid group in the 3-position before oxidation occurs.

The oxidation of N-methylnicotinamide is shown in reaction III. Since the amide group in the 3-position can be easily removed by saponification, the reaction can follow two courses (*a* and *b*). If N-methylnicotinamide is oxidized by our method, saponification does not occur, since a low temperature is maintained and the alkali and ferricyanide are added simultaneously. Only N-methyl-2-pyridone-3-carboxylamide is formed (reaction III *b*), which may be isolated by repeated extractions with chloroform. In the method of Huff, however, the alkali is added at room temperature, and before the ferricyanide. In this case reaction III *a* also occurs. Huff isolated only N-methyl-2-pyridone-5-carboxylic acid from the reaction mixture, and did not attempt to isolate N-methyl-2-pyridone-3-carboxylamide.

The following experiment confirms our previous results and clarifies those of Huff. Two 10-gm. portions of N-methylnicotinamide iodide were oxidized side by side, one according to our procedure and the other by a method similar to that of Huff. In the latter case the alkali was added to the solution of N-methylnicotinamide at room temperature, and the ferricyanide was added half an hour later. In both cases N-methyl-2-pyridone-3-carboxylamide was isolated from the reaction mixture; but the yield was greater by our method. No trace of N-methyl-2-pyridone-5-carboxylic acid could be found in the mother liquor when the oxidation was arranged to take place as described by us; but, when Huff's method was used, 0·5 gm. of crude N-methyl-2-pyridone-5-carboxylic acid was obtained. After further purification, by crystallization from water, the melting point was 238°, which agrees well with the value of 237–238° reported by von Pechmann and Welsh[5].

It is clear that only in method III *b* is the amide group present in the 3-position before oxidation, and that only in this case is the 2,3-isomer formed. It is also apparent that the method of Huff for the preparation of N-methyl-2-pyridone-5-carboxylic acid from N-methylnicotinamide represents a side-reaction, and does not indicate the true course of the oxidation of N-methylnicotinamide *in vitro*.

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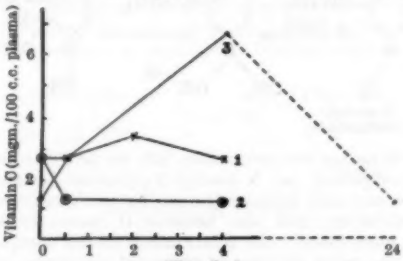
Species Difference in the Biosynthesis of Vitamin C and Response to Diabetogenic Substances

Tidwell and Axelrod[1] have recently confirmed the views of Nath and Brahmachari[2] regarding the initial stimulation of islet cells and excess production of internal insulin in the experimental animals by injection of intermediary fat metabolites, especially sodium aceto-acetate. Their findings that the condition of hyperglycæmia cannot be developed in rats even after the injection of sodium aceto-acetate for 28 days (daily dose 18 mgm. per 100 gm. body-weight) also confirm the recent findings of Nath and Brahmachari[3], who observed a 50 per cent increase in the potency of the pancreatic insulin of the treated guinea pigs in about twenty-five days, and a marked decrease in the activity of internal insulin only on prolonged injection for about seventy days.

In their three-day injection experiments, however, Tidwell and Axelrod observed that rats are far less susceptible to the action of aceto-acetate, especially towards the degree of increase in blood sugar, than the rabbits used by Nath and Brahmachari[3], and they (Tidwell and Axelrod) have pointed out that species difference might play an important part in the response to diabetogenic substances. Thus, though alloxan is known to cause marked diabetogenic effect on rats, Scott *et al.*[4] find little evidence of injury produced by it in islet cells in various species of birds, while Ruben and Yardumian[5] have shown that mere enteric absorption of alloxan is quite sufficient to injure the β-cells of the islets of rabbits.

Attempts were therefore made to see if such difference in behaviour could be accounted for through differences in the capacity for immediate biosynthesis of vitamin C, which is known to be highly beneficial in improving carbohydrate tolerance of diabetics[6]. Mosonyi[7] has shown that animals which produce ascorbic acid react to the administration of chemicals, especially of some ketones, by increasing the ascorbic acid excretion; though chloroform was ineffective in causing increase in the biosynthesis of vitamin C in rats, chloreton, a condensation product of acetone and chloroform, has been found by Ghosh[8] to exert great influence in the process.

In order to investigate the degree of biosynthesis in different animals (rats and rabbits) by means of a sudden shock caused through the injection of some intermediary fat metabolites, the following experiment was undertaken. Sodium aceto-acetate in the dose of 18 mgm. per 100 gm. body-weight was injected intramuscularly into some groups of animals



Curve 1: rabbits, 6 mgm. sodium aceto-acetate per 100 gm. body wt.
" 2: " 18 " " " "
" 3: rats, " " " "

of each kind, and the quantity of vitamin C in 100 c.c. of plasma was estimated colorimetrically (by means of a photo-electric colorimeter) according to the usual method with the indophenol dye. The results of the preliminary observation are represented graphically.

This figure shows that the rabbits are unable to adjust themselves with the biosynthesis of their high requirements of vitamin C in order to cope with the situation, but that rats can go on synthesizing it even with such a high dose of the keto compound. 6 mgm. of the keto acid per 100 gm. of the body-weight (that is, one-third of the previous dose) can, however, excite the mechanism of biosynthesis of vitamin C to some extent in rabbits.

Work has also been undertaken to study the influence of vitamin C in accelerating the process of ketolysis, as well as in checking the process of glycogenolysis by perfusion experiments with kidney and liver slice respectively in the Ringer's solution modified by Krebs[9]. 5 mgm. of vitamin C per c.c. of the reaction mixture is found to accelerate ketolysis by 70 per cent in thirty minutes in a solution containing 200 mgm. of sodium aceto-acetate per c.c.; and 2 and 5 mgm. of vitamin C have been found to inhibit the degree of glycogenolysis by 37 per cent and 60 per cent respectively in one hour.

Further work is in progress.

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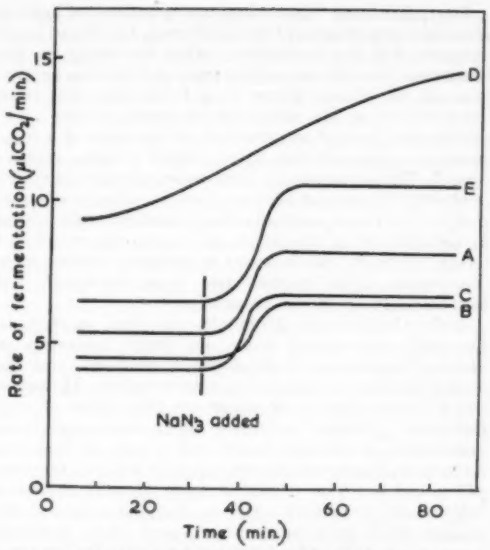
Use of Certain Growth-Inhibitors as Tools in Metabolic Investigations

Cultures of *Saccharomyces carlsbergensis* grown in the presence of sub-optimal amounts of vitamin B6, biotin, or pantothenic acid, and containing in each case less than one tenth of the normal quantity per mgm. of the growth-factor, possessed reduced rates of fermentation, which could be increased within a few minutes at most by addition of the latter. A rapid and marked stimulation was produced also by the addition of sodium azide in suitable concentrations; typical results are shown in the accompanying figure.

Sodium azide did not increase the rate of fermentation of the normal yeast in the medium containing ammonium sulphate (*D*). Growth of each yeast, in contrast, was strongly inhibited by the same concentration of azide.

Sodium azide, 2 : 4-dinitrophenol, and possibly certain other cell-poisons appear to release fermentation and respiration from the controlling influence of endergonic processes, exercised through the transphosphorylation mechanisms[1,2]. In view of this, the above results appear to indicate that vitamin B6, biotin, and pantothenic acid do not participate



Influence of vitamin deficiencies and sodium azide upon rate of fermentation by *S. carlsbergensis*. *A*, B6-deficient; *B*, pantothenic acid-deficient; *C*, biotin-deficient; *D*, and *E*, grown in medium containing all essential growth-factors. The liquid in the manometers contained glucose (3 per cent), KH_2PO_4 (*M*/30), $(NH_4)_2SO_4$ (2·5 mgm./ml.), and usual amounts of other mineral salts; $(NH_4)_2SO_4$ was omitted in *E*. Sodium azide was added at the points indicated; effective concentrations were 5×10^{-4} *M* for *A* and *E*, and 10^{-3} *M* for *B* and *C*. All fermentations were run at 30° C. in an atmosphere of nitrogen. 1 mgm. (dry weight) of yeast was used in each experiment

directly in the reactions involved in alcoholic fermentation; but influence the latter only indirectly by probable functions in the anabolic activities of the cell.

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Retinene$_1$ and Indicator Yellow

Ball, Collins, Morton and Stubbs[1] have found that retinene$_1$ may combine with various proteins and amino-acids to give compounds with the properties of Lythgoe's indicator yellow. This is an interesting advance in the chemistry of vision; but, as stated by Dartnall[2], does not prove that indicator yellow is a "fortuitous artefact having no direct relevance to visual chemistry".

However, Lythgoe's statement[3] that he was unable to extract retinene from bleached visual purple solutions, using petroleum ether alone as a solvent, has recently been shown by me to be erroneous[4]. Lythgoe failed probably because he did not shake his extract with enough vigour to compensate for the slow diffusion of the liberated retinene through the aqueous phase to the petroleum ether. Furthermore, even in the presence of an 'active agent' such as alcohol, retinene is not released to petroleum ether during a period of 2–10 min. after the solution is bleached[4]. This supports Dartnall's view that retinene itself is not split off the visual purple molecule by light. The actual photo-product is probably Lythgoe's transient orange[5].

Dartnall states "that when one quantum of light is absorbed one chromophore is altered, but there is no evidence for the statement, often occurring in the literature, that the secondary process following activation of the chromophore is a loosening, that is, a dissociation of the chromophore-protein bond". A similar conclusion[6] was reached on the basis of a comparative study of the squid visual purple, cephalopsin[7]. This substance is a retinene$_1$ compound which is chemically almost identical with vertebrate visual purple, but is not normally dissociated by light, either in solution or in the most sensitive preparations of living retinas[8]. An increase in retinene release from illuminated squid retinas has been reported[9], but has been shown to be an artefact[6].

Ball, Collins and Morton[10], in their answer to Dartnall, state that there are three materials in bleached solutions of rhodopsin: retinene, and the acid and alkaline forms of indicator yellow. However, according to Lythgoe[3] there are two forms of acid indicator yellow: a stable form with adsorption maximum at 450 mμ below *p*H 4 and an unstable form with absorption maximum near 445 mμ between *p*H 4 and 6. The unstable form of acid indicator yellow readily releases retinene when its solutions are shaken with petroleum ether[4], and thus probably corresponds to the "loosely bound retinene" mentioned by Ball, Collins and Morton.

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[1] Ball, S., Collins, F., Morton, R., and Stubbs, A., *Nature*, **161**, 424 (1948).
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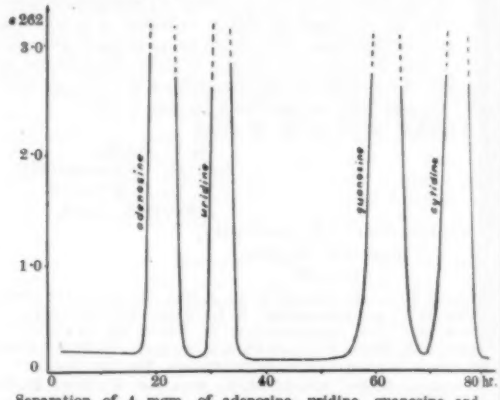
Partition Chromatography on Starch of Ribonucleosides

DURING work on ribonucleic acid turnover with nitrogen-15 in this Department, we found it necessary to isolate the different nitrogen-containing substances from small amounts of ribonucleic acid. It was thought that partition chromatography on starch as introduced by Elsden and Synge[1] might give a possible solution to our problem. Vischer and Chargaff[2] have applied partition chromatography on paper to the purine-bases; Edman, Hammarsten, Löw and Reichard[3] have worked out a method for separating guanine and adenine on a starch column. Tinker and Brown[4] have recently applied Craig's counter-current distribution technique to purines and pyrimidines and related compounds.

In regard to the pyrimidine bases, it seemed to be difficult to prepare them in a good yield from ribonucleic acid without destruction and conversion of cytosine to uracil during hydrolysis. The preparation of the ribonucleosides, however, was thought to be a simpler task, and a method for separating them from a mixture of the pure compounds on a starch column has been worked out.

The solvent chosen was butanol saturated with water. The starch was prepared by extracting ordinary commercial potato starch with methanol for 24 hours in a Soxhlet apparatus. The starch column was 200 mm. long and had an inner diameter of 23 mm. About 5 mgm. of each of the four pure ribonucleosides were dissolved in about 3 ml. of butanol–water and added to the top of the column. The butanol was run continuously for about three days; a sufficient head of liquid was kept in the column so that 5–7 ml. of fluid ran through the column per hour. The effluent was collected each hour by a simple apparatus constructed by Edman[5], and analysed in the Beckman spectrophotometer at 262 mμ. In this way the nucleosides may be easily localized (see graph). The different nucleosides have specific light absorption maxima around 262 mμ and may be characterized by comparing the light absorption at 262 mμ (maximum for uridine and adenosine), 248 mμ (guanosine) and 270 mμ (cytidine). Under these conditions, the values of R, according to Martin and Synge[6], for the different nucleosides were as follow: adenosine, 0·80; cytidine, 0·21; guanosine, 0·28; uridine, 0·52.



Separation of 4 mgm. of adenosine, uridine, guanosine and cytidine on a starch column 200 mm. long with butanol-water as the mobile phase

Samples containing the same nucleoside were combined, the solvent evaporated off and the residue dissolved in 0·1 *N* hydrochloric acid. The purity of the different compounds after chromatography was established by determining the ratio ε max./γ nitrogen per ml. These values obtained were: adenosine 0·196 (ε = 257 mμ); cytidine, 0·295 (ε = 280 mμ); guanosine, 0·164 (ε = 255 mμ); uridine, 0·332 (ε = 262 mμ).

The yield with about 5 mgm. of each nucleoside was 90–100 per cent. This method has been successfully applied in tracer experiments to hydrolysates of ribonucleic acid. The hydrolysis of ribonucleic acid to nucleosides was carried out with a pyridine–water mixture by a modification of Bredereck's method[7]. The results of these experiments will be published elsewhere.

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EIGHTEENTH SESSION OF THE INTERNATIONAL GEOLOGICAL CONGRESS

AN outline of plans for the eighteenth session of the International Geological Congress was given in *Nature*, August 7, p. 232. The proceedings lasted in all for a period of seven weeks during August and September. Much of the time was occupied by a series of thirty-seven long geological excursions, which visited important localities throughout Great Britain and eastern Ireland. Some 250 British geologists acted as organisers, directors and secretaries for these excursions and for an extensive series of additional short excursions centred on London. Despite indifferent weather, the excursion programme was extremely successful; it was clear that the excursion parties, which consisted predominantly of geologists from abroad, found interest and enjoyment in visiting the classic areas and type localities of the British Isles under the guidance of British specialists.

The formal and scientific meetings of the Congress, with an associated programme of receptions and entertainments, were held in South Kensington during August 25–September 1. The total membership of the session, including non-attending members, was more than 1,760; the total attendance of members and relatives was about sixteen hundred, including some nine hundred from overseas. Seventy-six different countries were represented; sixty-four Governments and 360 universities, societies and institutions sent official delegates.

This widely representative assembly provided the first full-scale opportunity for international geological discussion for eleven years—since the seventeenth session in Moscow; and throughout the Congress members made good use of the opportunity. The attendance at all the meetings and functions was very large. At times five sectional meetings, each with an attendance of some two hundred members, were simultaneously in progress. Audiences of nine hundred filled the lecture theatre of the Royal Geographical Society to hear special addresses by Prof. O. T. Jones and Sir Edward Bailey on "The Structural History of Britain". Colour films of the Mexican volcano Paricutin, presented by Dr. J. G. Reyna and Dr. F. H. Pough, and of the Virunga volcanoes of Africa, presented by Prof. T. W. Gevers, were shown twice because the same theatre could not hold at one time all who wished to see them. More than fourteen hundred members attended a reception by H.M. Government on the first day of the session, and a similar number were present at a reception by the Geological Society on August 31. Some six hundred official delegates and relatives were received by the Vice-Chancellor of the University of London on August 30, and many other receptions and entertainments were also successfully arranged. In addition to the formal items of the programme, members made full use for informal meeting and discussion of extensive lounge accommodation in the Geological Survey and Museum, which was the headquarters and registry of the Congress.

At the inaugural meeting in the Royal Albert Hall, Prof. H. H. Read, president of the Geological Society of London, was elected president of the Congress. Viscount Addison, Lord Privy Seal, welcomed the assembly on behalf of H.M. Government, and Sir John Anderson, honorary president of the General Organising Committee, explained how, under the ægis of the Geological Society and with active Government support through the Geological Survey and Museum, professional and amateur geologists throughout Britain had worked in face of considerable difficulties to make the Congress a success. From speeches by the heads of Government delegations at the final meeting of the general assembly on September 1, and from much informal comment, it can be judged that the delegates and members were, in fact, well pleased and satisfied with the arrangements which had been made.

During the session, the Council of the Congress arranged for the reconstitution of many of its international commissions, the work of which had been interrupted during the War. A full account of the proceedings of the Council, and of the sectional meetings, to which some 350 papers were offered, will be published in the report of the Session, but at least twelve months must necessarily elapse before this can be issued. Meanwhile, summaries of the more important decisions of the Council, and of the sectional proceedings, will appear in forthcoming numbers of the *Geological Magazine*. Further articles will also appear in *Nature*.

The Congress accepted with pleasure an invitation from the Government of France to hold the nineteenth session in Algiers in 1952. At the same time it expressed its gratitude for an invitation from the Government of India, and it is hoped that the invitation to meet in India may be renewed at the nineteenth session.

SCHOOL OF PHARMACY, UNIVERSITY OF LONDON

THE Dean of the College of the Pharmaceutical Society announced at the 107th inaugural meeting on October 6 that the College is to be reconstituted on an independent basis and renamed the School of Pharmacy, University of London. It will be financed mainly from University funds.

This event marks the end of a phase of pharmaceutical education in Britain which was identified with the efforts of the members of the Pharmaceutical Society, who from their foundation in 1841 proceeded energetically to raise the status of their calling by promoting a modern system of professional education. Their aim was reaffirmed in the charter which the Society obtained in 1843, the objects of which included "the advancement of chemistry and pharmacy and the promotion of a uniform system of education". In pursuance of this policy the Society founded in 1842 what was at first known as the School of Pharmacy, the name being changed in 1926 to "The College of the Pharmaceutical Society".

The history of the School is a record of an attempt by a professional body to carry the burden of its own educational advancement, and all will join in paying tribute to the Society for success in that aim. The School from its inception has made outstanding contributions to our knowledge of pharmacy, chemistry, materia medica and medicine. The record of more than a century of endeavour is one which must redound to the credit of the Pharmaceutical Society. In 1842, with the prescience of enlightened educationists, the Society equipped and staffed a pioneer establishment on a scale which ultimately yielded rich dividends. A chemistry laboratory was established in that year which was one of the first of

its type in Great Britain and which would at that time bear comparison with the best of its kind in Europe. It has housed a long list of distinguished professors, each of whom added an important quota to his science. Thus in chemistry we see the names Aufield, 1862; Tilden, 1865; Palmer Wynne, 1896; Collie, 1902; Crossley, 1904; and Dunstan, 1905; and in botany those of such figures as Robert Bentley, 1849, and Reynolds Green, 1887. In pharmacy and materia medica came Pereira, Redwood, Ince, Greenish and Wallis. The early days of the School saw the development of the use of the microscope by Greenish in the evaluation of powdered drugs. Its latter years saw the establishment, by Burn, of pharmacological laboratories for research work in methods of biological assays, and the years between had a record of steady achievement which was marked in 1926 by the recognition of the School by the University of London as a School of the University and by the establishment of a degree in pharmacy.

The reconstitution of the School brings to an end a fruitful regime of a hundred and six years, and inaugurates a new era which it is hoped to make even more productive of benefit to pharmacy than the old. Under its new title, the School will have an independent existence with a new governing body, a Council which will consist of the Dean (Prof. H. Berry), together with the following members: (*a*) nominated by the University of London: Dr. O. L. Brady, Sir Archibald Gray, Mr. John Hunter and Dr. G. B. Jeffery; (*b*) nominated by the Academic Board of the College: Prof. G. A. H. Buttle, Dr. Katharine Coward, Dr. J. W. Fairbairn and Prof. W. H. Linnell; (*c*) nominated by the Pharmaceutical Society: Mr. W. S. Howells, Mrs. J. C. Irvine, Mr. H. N. Linstead and Mr. C. W. Maplethorpe; together with three co-opted members: Sir Henry Dale, Mr. W. J. C. Quarrell and Sir Harry Jephcott, who becomes chairman of the new School Council. Mr. S. R. Curtis has been appointed secretary to the School.

BRITISH EMPIRE CANCER CAMPAIGN

THE twenty-fifth annual report of the British Empire Cancer Campaign covers the work done during the latter half of 1947. To those not acquainted with the ramifications of modern cancer research, much of the work in the report will occasion surprise, owing to its apparent lack of connexion with the subject. But the fact is that the problem of malignant growth is inextricably bound up with peculiarities of cellular respiration, nutritional requirements, hormone balance and interaction of enzyme systems; and its study demands contributions from almost every branch of science.

In the sphere of radiation physics, work has been mainly concerned with preparing the way for the future use of high-voltage radiation and of radioactive isotopes. To this end refinements of methods for accurate measurement of dosage, which becomes of increasing difficulty and importance under these conditions, have been developed. Measurements of extraneous radiations likely to harm personnel engaged in radiation therapy have also been carried out. During the year, further studies have been made on the biological effects of radiations. The extreme rapidity with which cellular changes occur is astonishing. Thus Prof. J. S. Mitchell has shown that within seven minutes of exposing cultures of chick embryo fibroblasts to X-irradiation, alterations occur in the amount of substances in the cells which cause absorption of ultra-violet light of wave-length 2537 A. Ribose nucleic acid is believed to be largely responsible for such absorption; but the possibility that other substances may be concerned is receiving attention. By standard histological methods pycnotic changes in the cell nuclei of the membrana granulosa of large ovarian follicles can be demonstrated within four hours of irradiating rats (L. Halberstaedter and M. Ickowicz). By the use of radioactive phosphorus (P^{32}) uptake as a measure of thymonucleic acid formation, Mrs. B. E. Holmes has adduced evidence that therapeutic doses of X-rays reduce the synthesis of this substance, and that this reduction may be an integral part of the damaging effects of radiations. On the clinical side, an important practical outcome of A. Glücksmann and L. G. Spear's histological method of assessing the progress of radiation therapy in cancer of the cervix uteri has been that, on the strength of it, several cases have been submitted to radical surgery, irradiation having been abandoned although in some cases the clinical response seemed favourable. In every case examination of the operation specimens showed the malignant process to be active.

Among the clinical reports is an analysis from Birmingham of survival-rates of 1,367 cases of cancer of the breast observed between 1936 and 1942. The accepted clinical opinion that the results of surgery combined with radiotherapy are superior to those of either form of treatment alone receives statistical confirmation. Owing to the small numbers, however, it is not possible to decide whether pre-operative or post-operative irradiation is the more effective method; though in the series quoted, post-operative treatment gave the better results. From St. Mark's Hospital come some important figures relating to cancer of the rectum. Of 716 cases treated between 1928 and 1941, just under half survived five years or more. But the five-year survival-rate of cases with disease confined to the rectum was more than 80 per cent, whereas those in which lymphatic metastases were present had a five-year survival-rate of just over 25 per cent. The correlation between the histological appearance of the growths and the extent of metastases was high in this series. Lymphatic spread was present in 80 per cent of cases in which 'high grade' malignancy was reported histologically; but in only 20 per cent of those reported as 'low grade'. In a very full report by the Clinical Cancer Research Committee on malignant disease of kidney, bladder and prostate, the figures concern cases treated before œstrogen therapy had been introduced for the last-named disease, and will therefore be useful for comparison with similar figures when the results of such treatment are available.

Sir Ernest Kennaway's study of the effect of circumcision on the subsequent development of cancer of the penis has already excited comment in the medical Press. He finds that the operation protects against cancer if performed at eight days, but confers no protection when carried out after the fourteenth year. "The failure of the operation deferred until the 14th year to give the protection given by it when carried out on the 8th day suggests that the train of events leading to malignant growth is set going early in life, and that removal of the cause

does not then avert the development of cancer at a much later age." In the experimental field the component processes which constitute "the train of events leading to malignant growth" have been characterized with greater clarity during the last fifteen years. Dr. I. Berenblum and Dr. P. Shubik have now placed such studies on a quantitative footing. Dr. Berenblum had earlier shown that croton oil, itself non-carcinogenic, would cause growths to appear when painted on the skin of mice previously treated with doses of known carcinogens insufficient to provoke neoplasia. The late Dr. J. C. Mottram showed that a single painting of carcinogen was effective when followed by croton oil applications. Using different carcinogens and varying the number and frequency of croton oil applications, Berenblum and Shubik have shown that two entirely distinct mechanisms enter into the carcinogenetic process in mouse skin. The initial painting with carcinogen produces some invisible, irreversible alteration in a few of the cells of the painted area—the 'initiating' process. The 'initiated' cells remain dormant until stimulated into activity by a 'promoting' agent—in these experiments croton oil. The recognition of these two stages explains certain discrepancies which have been encountered in assessing the carcinogenic potency of certain compounds. A compound may be a powerful initiator but a poor promoter. If its activity is measured in terms of minimal dose response it will be labelled a powerful carcinogen, since this measurement is essentially that of initiating action; whereas if average latent period for tumour production is the measurement chosen, its activity will be poor, average latent period indicating promoting action.

Of medical interest is the finding of workers in Oxford that liquor picis carb. B.P., a commonly used coal-tar preparation, sometimes prescribed for long periods, contains 0·02 per cent benzpyrene, and produced papillomas in ten weeks when painted twice weekly on mouse skin. After twenty-six weeks, 50 per cent of survivors had tumours, more than half of which became malignant.

Further work on recently discovered carcinogens has been done during the year. A curious property of 2-acetylaminofluorene, namely, the production of epitheliomas of the external auditory meatal wall, is shared by 4-dimethylaminostilbene. Taking advantage of the characteristic brilliant fluorescence of the latter compound in ultra-violet light, Glasgow workers have shown that it is excreted in the cerumen, which would account for the unusual site of tumour growth.

Work on growth inhibitors at the Royal Cancer Hospital has been considerably extended. 4-N : N-di-(2 chloroethyl)-aminostilbene, which possesses the chloroethyl groups characteristic of the nitrogen mustards, has a marked but short-lived inhibitory effect on the Walker rat carcinoma. The N : N-di-2-chloroethyl side-chain was introduced into many aromatic amines, and marked inhibitory activity has been demonstrated in the aniline, *o*-, *m*- and *p*-toluidines, *o*- and *p*-anisidine, β-naphthylamine, and *p*-aminobenzoic acid derivatives.

Much work is presented on tumour viruses. Prof. R. D. Passey and his colleagues at Leeds have examined extracts of tissues from breast tumours, and normal tissues from high- and low-cancer strain mice by means of electron microscopy. Extracts made from all tissues and from the milk of high-cancer strains consistently show numerous spherical particles of the order of 250 A. diameter. These particles are absent, or only present sporadically, in similar material from low-cancer strains. Ultra-centrifugation at 60,000–120,000 *g* removes the particles from the extracts. Even after the drastic process of extraction employed, the samples in which the particles are numerous incite mammary tumours when inoculated into susceptible mice. The particles are thus closely associated with milk-factor activity; but the authors stress the need for caution in interpreting the findings.

The *British Journal of Cancer*, which is sponsored by the Campaign, has now completed a year of publication and gives an indication of the quality and breadth of cancer research in Britain. The present report includes work from new centres, such as the University of Bristol, the Hebrew University at Jerusalem and the University of Glasgow, which indicate how the activities of the Campaign are still growing twenty-five years after its foundation.

D. A. G. GALTON

AN ELECTRON MICROSCOPE STUDY OF CELLULOSE IN THE WALL OF *VALONIA VENTRICOSA*

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DURING the past thirty years or so, intensive investigation of cellulose by various physical methods has directed attention repeatedly to the possible existence of supermolecular units of structure ranging from 'fibrils'[1] some 0·4 μ in diameter and of indefinite length to small spherical or ellipsoidal particles of diameter up to 1·5 μ [2].

While this has lent colour to speculations by earlier workers based largely on microscopical observations[3], it has never been clear that the newer physical methods yielded any more precise a picture of these units than did mere microscopical observation; nor, indeed, could it be claimed that proof had ever been given of the concrete existence of any such units in the intact, untreated walls of plant cells. With the advent of electron microscopy, however, and especially following the notable advance in manipulative technique using metal shadowing and surface replication, it became at last possible to make a direct attack on this particular aspect of cellulose structure.

Few of the many existing electron micrographs of cellulose have been very informative other than to show that, under suitable treatment, cellulose can be broken down into fibrous bodies. This has been due largely to the unfortunate choice for experimental material of either drastically treated celluloses such as filter paper or of mechanically disintegrated cellular tissues which are difficult to manipulate and the photographs of which are, by their very nature, almost uninterpretable[4].

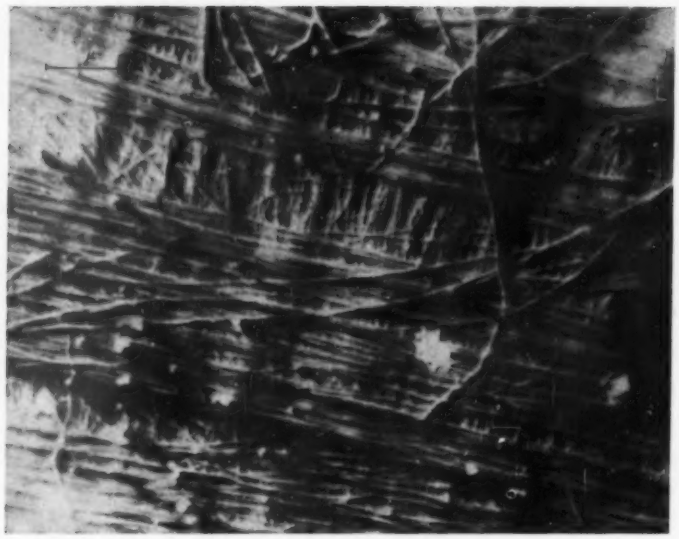

Fig. 1

The technique clearly demands a cell wall of large area, strong enough to be handled without material deformation, and the fine structure of which is already known in sufficient detail to make interpretation possible.

All these desiderata are fulfilled by the walls of the vesicles of *Valonia ventricosa*, and during the course of an intensive investigation of the cell walls of algæ initiated in the Botany Department at Leeds the organisation in this particular species, the fine structure of which is already well known[5,6], is being studied with the electron microscope. While the investigation is as yet only in the preliminary stages, the photographs obtained are already so striking that it has been thought desirable to direct attention to some of their more important features. It is not proposed to describe at this time the methods used in the preparation of the specimens examined in the microscope, except to say that all the photographs are of surface replicas, in 'Formvar' or collodion, of chromium-shadowed wall material cut from the vesicles without distortion.

Fig. 1 shows the appearance of the wall surface and Fig. 2 that of intermediate lamellæ in the wall laid bare by stripping and representing, if not the actual inner surface of the wall next to the cytoplasm, at least the condition very close to this surface.

Both photographs show a number of points of outstanding interest. First, and perhaps most unexpectedly, the wall appears to consist of fibres of indefinite length the diameters of which vary between surprisingly narrow limits around about 300 A. The uniformity alone of these fibres makes it rather certain that they are an intrinsic feature of the wall not artefacts due to intensive drying, etc., and can therefore be considered as fundamental building units of cellulose, at least as found in this particular alga. Certainly the particle hypothesis as proposed by Farr and Eckerson, upon which considerable doubt has already been cast[7], is once and for all shown invalid. The 'fibrils', on the other hand, already described for *Valonia*[8] are clearly aggregates of indefinite numbers of these fibres. At the same time, it is possibly significant to note that occasionally the clear impression is given of the presence in the wall of spherical particles, some 300 A. in diameter, linearly arranged and suggesting, therefore, a unit of smaller dimension.

Secondly, within any one lamella the fibres run closely parallel to one another, with the exception of occasional stray fibres which have probably been displaced during the preparation of the specimen. This is in harmony with the X-ray photographs[9].

Thirdly, in an adjacent lamella which can be observed through the interstices in the upper lamella, similar fibres are clearly visible which lie at an angle to the first set commonly rather less than a right angle (Fig. 1), but occasionally much less (Fig. 2), and sometimes a third orientation can be detected (Fig. 2). All this again is in harmony with the X-ray photographs, though at the moment it appears that

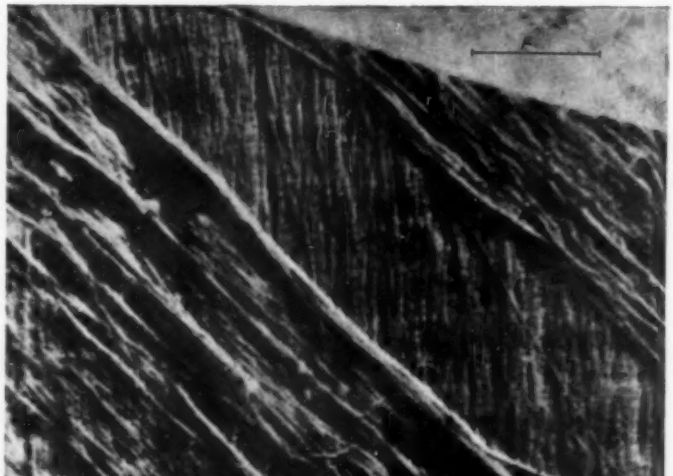

Fig. 2

the third orientation is more prevalent than these photographs gave reason to suspect.

It is clearly too early to speculate upon the precise nature of these fibres or to express any opinion as to the way in which they are produced by the plant. So far as the photographs go, however, they certainly give the impression that the fibres might be regarded as 'crystallites' of cellulose, and this would be in harmony with those properties of this particular wall which suggest a high degree of crystallinity. The density, for example, is the highest yet recorded[8] for cellulose (1·562) and suggests a crystalline/non-crystalline ratio of about 71 per cent. A determination of this ratio made for the senior author by P. H. Hermans of Utrecht (using his X-ray method), to whom our thanks are due, is on the other hand disappointingly low—lying between the values for native fibres and for wood pulp. This may, however, be due to impurities in the specimen sent to him. (A more recent determination on a purified sample is reported by Dr. Hermans to indicate a crystalline/non-crystalline ratio of 67–68 per cent.) The orientation of the fibres must be remarkably perfect, for it must be recalled that in this wall the molecular planes of 6·1 A. spacing tend to lie parallel to the wall surface. If the fibres are isodiametric in cross-section, such orientation could arise only through the prevalence of —OH groups in this plane, and would therefore presumably be initiated at the moment of deposition at the cytoplasm-wall interface, and not secondarily by changes within the mature wall. If, on the other hand, the fibres are flat ribbons (and the photographs as yet offer no evidence on this point), then the orientation could arise mechanically; though even then the orientation is not induced merely by drying, as it is in bacterial cellulose, for precisely the same condition has been demonstrated in undried algæ[9]. Finally, it should be noted that since the fibres run uninterruptedly with apparently smooth sides over distances much greater than 10 μ (width of the photographs taken), their appearance lends no support to the 'fringed micelle' hypothesis but tends rather to suggest the continuous, periodically distorted structure suggested by Meyer[10].

The senior author is indebted to Prof. W. T. Astbury, of the Department of Biomolecular Structure, for valued advice and for placing the facilities of the electron microscope at his disposal, and to the Department of Scientific and Industrial Research for a grant defraying in part the expenses of the algal research.

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THE YOUNG WORKER IN INDUSTRY

AT the discussion on "The Young Worker in Industry" arranged by Section L (Education) of the British Association on September 13, the two main contributions were from representatives of industry and of the Ministry of Education. In the first paper, which dealt with recent progress in industrial education and training, the authors pointed out that the increasing scale and complexity of British industry since the industrial revolution has been paralleled by a widening appreciation of the need for industrial workers to know something of the principles underlying the industrial arts. The establishment of the mechanics institutes and, later, technical colleges, works' schools and junior technical schools was part of the practical response to this need, as was, more recently, the setting up of the system of national certificates and the part-time day release by industry of young personnel for technical study.

War-time demands for skilled personnel stimulated realistic thinking and practical developments in the fields of selection and training. War and the post-war economic difficulties have also thrown into relief the social need for maximum economy in the use of man-power. To secure this, it is essential that all young people receive the type of education and training best suited to their interests and natural aptitudes. In this, industry has an important part to play, not only in providing information regarding the types of careers available, but also in establishing training schemes, a function of which should be the assessment under practical conditions of the trainees' suitability, not with the view of 'weeding out' failures so much as of providing training for a suitable alternative occupation where one course of training proves inappropriate.

The story of national education in Britain between the two World Wars is one of the failure in the practical application of the ideals of the Fisher Act, followed by renewed planning represented by the reports of the Consultative Committee between 1925 and 1938. The trade recessions of this period also checked progress in industrial and commercial training, which was largely in the hands of private enterprise. Some enlightened firms, however, endeavoured to repair the gaps with their works' schools, some of which have a long history. The experience gained in these schools should be of value in connexion with the proposed county colleges. The interest which young workers have in further education is, in most cases, best stimulated by basing it on their work and environment. It is suggested that the initiation courses run by many firms to help young people to bridge the gap between full-time schooling and wage earning could be paralleled by wider courses, designed with the same intent, in the county colleges to be established.

Apprenticeship is an aspect of training in which appreciable progress has been made in industry since the end of the First World War, particularly in the more technical industries such as engineering. Some of the largest concerns have comprehensive apprenticeship schemes with grades according to the educational levels of entrants—craft apprenticeship for boys from secondary modern and secondary technical schools, student apprenticeship for boys from secondary grammar and from public schools,

and graduate apprenticeship for young men and women graduates. The difficulty of smaller firms in supporting schemes on such an ambitious scale is one reason for the modern tendency to discuss and plan apprenticeship schemes at a regional and national level.

Attention has also been given to practical training at the professional level, particularly in the engineering industry. For example, the Institution of Electrical Engineers has published no less than three booklets on training for the electrical industry between 1942 and 1947. The report published in 1947 makes recommendations based on the best in modern training practice in this field, and lays down practical training standards designed to secure for the young professional engineer the width of experience and consequent flexibility necessary for the continued progress of the industry. One specific recommendation is that graduate apprentices should be given leave of absence by their firms to widen their experience not only in Great Britain but also overseas. This recommendation is already being carried out by some firms, and an increasing number of overseas contacts is being made. Many foreign students are coming to Great Britain for engineering training both theoretical and practical. There is no reason why an interchange of craftsmen and technicians, as well as young professional engineers, could not be arranged to give human reality to political and economic union between countries. Already the merits of British methods of training professional engineers are widely recognized. If this reputation can be extended to other industries and vocations, Britain will have made a contribution to world prosperity equal to that made by its scientific men in the field of knowledge.

The second paper, by a representative of the Ministry of Education, indicated that it has always been traditional in Great Britain for our educational institutions to provide for the educational needs and interests of the young worker rather than for the needs of industry as such, and that likewise it is traditional for industry to take responsibility for the practical training of its young workers and to look to our educational institutions for the provision of technology and general education. The needs of industry and the interests of young people are not always identical, and it was to avoid indiscriminate recruitment regardless of aptitudes that the Juvenile Employment Service—now called the Youth Employment Service—was set up. To be fully effective, this Service must have the support of parents, teachers and employers, and be staffed with officers expertly trained in vocational guidance and having a wide knowledge of industrial conditions, so as to effect good 'placing' and to 'follow up' such placing. Much research is called for in this field.

The educational needs of young workers once they are in industry are very varied, depending on their educational level at entry and on their aspirations; but that further education must be available is now an accepted need for all. Only 30–40 per cent of 'school-leavers' at present receive any further formal education.

Of these, too high a proportion can only acquire their technology at night at the expense of their leisure, and a 40-hour week for the adult should not make us indifferent to the 60-hour week of many apprentices. The larger firms which provide systematic industrial training in works' schools usually have a close link with the technical colleges and appreciate the need for day-time release—200,000 young workers are now released for such training as compared with 40,000 in 1938. In the smaller works, many are too small to provide even good practical training facilities.

The provision of the 1944 Education Act for compulsory day-time release for young people up to the age of eighteen years tries to provide a partial answer to the problem of the youth who ends his formal education at the school-leaving age of fifteen—'partial' because industry must attempt to do its share and the work in the county colleges to be set up under the Act should be complementary to industrial training. Within the past few years, some hundreds of education officers and personnel managers have been appointed by industrial employers for the specific purpose of furthering educational activities, and their influence is already having a marked effect. But such developments are limited in general to the larger industrial firms, and the problem of the smaller firms still remains. There are a number of ways in which the educational system can help to make up for the deficiencies of education and training within industry. One is to send young apprentices to the local technical college for full-time training for one or more years, and another is to release apprentices for 'sandwich' courses in colleges for full-time periods of varying length followed by part-time day release.

Pressure from industry to augment facilities for further education of the young worker is causing the Ministry of Education some embarrassment. The county colleges cannot at present be introduced. The difficulties of interesting the bulk of adolescents, who by the very nature of the industrial structure of Britain must become unskilled workers, in further education are well recognized; but if successful, the education provided by the county college will solve many problems. It will lay a foundation for adult life; develop regular habits of study and work; a pride in a job well done; a healthy interest in recreational pursuits, and fit the young people to play their part in the struggle for industrial survival.

Although not yet ready to introduce the county colleges, the local education authorities in Britain have been asked to plan their provision as an integral part of the whole field of further education. In the large cities there will be one or more central colleges for advanced studies for those over eighteen, and satellite branch colleges to meet the varied needs of those under eighteen. Vocational training and general education will not be separated. In smaller cities and towns there will be small colleges to meet the needs of day and evening courses for youths and adults.

A vital problem in educating youth in industry is to secure permanent liaison between the colleges and industry, and it is hoped that this has been effected by the nation-wide system of Regional Advisory Councils, consisting of representatives of industry and the colleges, the local education authorities and the universities.

The system of further education and training in Britain is complex and untidy; but it has achieved success largely by its voluntary nature, for it is democratic and flexible and comparatively easy to develop in the ways best suited to our people. The technical colleges employ large numbers of expert technologists from industry as teachers, and it is hoped this will continue when the training is carried on in the day-time. The Ministry has been encour-

aging developments by setting up three training colleges for the training of technical teachers, by facilitating the release of teachers to industry and by encouraging research.

In the discussion which followed the main papers, reference was made to the valuable assistance being given by some industrial concerns to technical education by providing materials and teaching staff. One speaker stressed the need that the selection of vocations should not be made too early; another that small firms had the one great advantage of being able to keep in closer touch with their young workers than can the larger concerns. Listening to all the contributions to the session, one was particularly struck with the obviously growing interest of industry in the education and training of the young worker, and the growing co-operation between employers, organised labour, and the education authorities.

A. P. M. FLEMING

SOCIETY FOR APPLIED BACTERIOLOGY

THE annual general meeting and conference of the Society was held during July 27–30 in the Department of Agriculture, Queen's University, Belfast. Approximately a hundred members and visitors attended the conference.

Agriculture, and particularly dairying, being the principal industry of Ulster, papers on dairy bacteriology predominated among the seventeen contributions submitted to the conference. The first session, on July 27, was devoted to four papers from Northern Ireland workers.

Mr. P. L. Clerkin, of the Bacteriology Division, described the development of the dairy industry in Northern Ireland during the past two decades with particular reference to the methods of bacteriological control. A feature of the Northern Ireland procedure for raw milk is the classification of liquid supplies into three grades designated simply *A*, *B* and *C*. Grade *A* is the produce of tuberculin-tested herds, bottled on the farm and sold raw. It must conform to fairly high bacteriological standards. Grades *B* and *C* have lower bacteriological standards and the bulk of such supplies is pasteurized. To assist the ready identification of the milk by the consumer, coloured labels, bottle-caps, etc., were assigned for each grade. This procedure was of interest since the authorities in Great Britain have consistently masked the identity of graded milk supplies under names which convey little or no information to the consumer. Legislation controlling ice-cream quality was introduced in Northern Ireland in 1938 and the Bacteriology Division advised on suitable hygienic standards. In this field, the Ulster authorities have been in advance of England and Wales.

Drs. Lamont and Kerr and Mr. McGirr, of the Northern Ireland Veterinary Division, submitted a paper on the Stormont technique of tuberculin testing. This technique was based on observations indicating that, in the tuberculous bovine, intradermal tuberculin injections exhibited increased sensitivity to a second tuberculin injection given seven days after the primary inoculation. The diagnostic feature is the increase in skin thickness and *not* the nature of the reaction. Results are now available for 590 animals subjected to the new procedure and afterwards slaughtered for post-mortem examination. The results showed that the Stormont test had a total error of 3·4 per cent, of which 2 per cent were undetected infected animals.

Lamont and his co-workers have also studied the white blood cell changes in relation to tuberculin testing with particular reference to the new technique. The most striking finding is that the blood reaction with the Stormont technique is very marked, there being a pronounced rise in the polymorph-lymphocyte ratio. The maximum alteration in the ratio appears at varying periods, hence for diagnostic purposes multiple bleeding would be necessary. Using white blood cells, Lamont and his colleagues have succeeded in passively transferring tuberculin sensitivity from the bovine to guinea pigs. These findings offer fairly concrete proof of the presence of the antibody responsible for tuberculin sensitivity. In general, this work supports the thesis recently propounded in a number of American publications that white blood cells and particularly lymphocytes play a very important part in the genesis and manifestations of many immune phenomena.

Dr. Pearson, also of the Veterinary Division of the Ministry, presented a paper on the limitations of penicillin in the treatment and control of bovine mastitis. The North of Ireland experience indicates that clinical mastitis, as encountered by the veterinary surgeon, requires much more individual consideration than is usually given, before penicillin is prescribed. The symptoms of streptococcal and staphylococcal infections are becoming more and more difficult to differentiate, and in Ulster in recent years there has been a definite increase in staphylococcal infections of the udder. In many of these cases little or no response has been shown to penicillin therapy, the organisms being invariably penicillin-resistant. This resistance may possibly have developed during previous penicillin treatment of sporadic mastitis. Strains of resistant streptococci have not become such a problem although such strains undoubtedly exist. Treatment of *Corynebacterium pyogenes* mastitis with penicillin has been found to be a waste of time and money. During recent years there has been a marked increase in the number of samples from clinically positive cases of mastitis, where it has been impossible to detect any causal organisms either culturally or microscopically.

Mr. J. G. Murray, of the Bacteriology Division, contributed a paper on ropy contamination of pasteurized milk. In a recent outbreak the principal source of such organisms was found to be contaminated milk bottles, *Bacterium aerogenes* being the principal contaminant. These organisms were frequently missed when incubated in bile salt broth at 37° C.; but at 22° and 30° C. they were readily detectable. Mixed cultures of slime-producing organisms were also occasionally present.

The second paper-reading session, on July 28, opened with a paper on factors affecting the bacterial population of lake waters by Dr. C. B. Taylor, of the Freshwater Biological Association, Wray Castle, Ambleside. The bacteria present in lake water may be considered in three categories: (*a*) those washed in from outside sources, of which a large population will ultimately perish although others may find conditions suitable for growth; (*b*) indigenous bacteria capable of existence in a dilute nutrient solution, as represented by lake water, and able to use for growth low concentrations of available organic matter, such types being probably ubiquitous; (*c*) bacteria dependent on a solid surface for their

proliferation and found in connexion with plankton cells. Group (*a*) reflect the amount of pollution in the watershed, and their numbers in the inflowing water are at the maximum for a few hours after heavy rain. Normally they only mix with the lake water to an appreciable extent in winter. Group (*b*) are types with very weak physiological activity and very low powers of resistance to unfavourable circumstances. An appreciable number are pigmented, yellow being the most common colour. This group is at its most numerous during the winter months. Group (*c*) are most common during periods when algal cells are present to afford sites for attachment.

Dr. Taylor, along with his colleague, Mr. C. H. Foot, also presented a paper on the most suitable medium for growth of bacteria from water. An interesting point in their findings was the fact that sufficient available nitrogenous organic matter is present in ordinary agar to satisfy the requirements of most water bacteria. Plain agar with the addition of salts, incubated at 20° C. for ten days, reproduced 80 per cent of the colonies found on a standard medium. Beef extract, a concentration of 0·5 per cent peptone and nitrate ($NaNO_3$) were found to be restrictive to bacterial growth.

Dr. Cunningham and Mr. McLeod, of the East of Scotland College of Agriculture, presented a short paper on the occurrence of *Bact. coli* Type I coliform organisms in the bovine udder. The evidence of the occurrence of persistent coliform infection of the udder in the absence of macroscopic symptoms is weak. In the case quoted by Cunningham and McLeod the numbers of organisms varied between 25 and more than 1,000 per ml. but usually were of the order of a few hundred. The numbers varied only slightly from day to day and also in the fore-milk, mid-milk and strippings. During the course of the investigation the cow went dry, and after calving the same quarter was again found to be infected. The practical importance of the finding is the fact that the coliform test is still applicable in Scotland for designated milk and, in the case in question, the milk supply failed to satisfy the required standards when the milk from the infected animal was included in the bulk milk of the herd.

Mr. A. Rowlands and Mr. W. A. Hoy, of the National Institute for Research in Dairying, Reading, presented the results of experiments with the lye (or caustic soda) method of treating milking machine teat cup clusters and milk tubes. This method is almost universal in the United States ; but so far has not been given official backing in Great Britain. The Reading results were entirely satisfactory even under known unsatisfactory conditions. Chlorination of the lye solution was found to be a useful additional safeguard.

In the final paper-reading session, on July 30, Miss M. E. Sharpe, of the National Institute for Research in Dairying, discussed some of the biochemical characteristics of Group *D* streptococci isolated from infants' fæces with special reference to their tyrosine decarboxylase activity. A definite association was found between tyrosine decarboxylase activity and the biochemical characteristics on which the sub-division into species has been made. *Str. fæcalis* and its varieties *zymogenes* and *liquefaciens* show a high tyrosine decarboxylase activity. *Str. durans* has an intermediate activity and *Str. bovis* and the unclassified strains have little or no activity. No strains of Group *D* streptococci which ferment raffinose produced tyrosine decarboxylase.

Miss E. R. Hiscox, of the National Institute for Research in Dairying, Reading, dealt with some of the factors affecting the ripening of pasteurized milk cheese. Since cheese-making is now largely a factory process, pasteurization of the milk prior to manufacture affords the advantages of standardization, uniformity and elimination of many faults. The cheese, however, as a rule is slower in ripening and lacks the typical flavour of the variety concerned. In Miss Hiscox's investigations raw milk cheese had twice the volatile acidity of the pasteurized milk cheese and few lipolytic organisms were found in the pasteurized milk cheese. Since flavour is probably the combined effect of fat lipolysis and volatile acids, the reason for poor flavour development in pasteurized milk cheese is apparent. The question has now arisen whether flavour can be restored by the use of suitable inoculants, and recent American work has been directed to this end.

Mr. J. Wolf, of the University of Leeds, submitted a short paper on the germicidal properties of tar acids present in producer gas tars. The germicidal properties of these tar acids are rather low as determined by the Rideal–Walker coefficient. A marked increase in the Rideal–Walker coefficient was attained when the tar acid emulsion was chlorinated by various methods. This work suggests that tar acids from producer gas tars might provide a useful source of germicides.

The subjects covered by other papers included a review of the microbiology of composting ; the survival of the microflora of milk powders at different relative humidities ; a modified acidity test for use on the milk reception platform of dairies, and studies of the thermoduric bacterial flora of raw milk.

Details of the papers will be published in due course in the *Proceedings of the Society for Applied Bacteriology*, the editor of which is Dr. T. Richards, Department of Agricultural Bacteriology, University of Reading.

FREE ENERGY OF PROTEIN SOLUTIONS

THE annual general meeting and conference of the Society of Leather Trades' Chemists was held on September 17 and 18 at the University of Leeds, Mr. G. Jessup Cutbush, vice-president of the Society, presiding. Included in the proceedings was the delivery of the third Procter Memorial Lecture, by Mr. G. S. Adair, reader in biophysics, University of Cambridge, who spoke on "Recent Work on Osmotic Pressures, Membrane Equilibrium and the Generalized Free Energy of Protein Solutions in the Light of the Work of Procter". Mr. Adair remarked that this year is the centenary of the birth of Henry Richardson Procter, and the occasion was also noteworthy since the commemoration lecture was being delivered in Leeds, where his work was carried out.

Procter's theory of the swelling of gelatin in hydrochloric acid was described by Loeb as one of the most original and ingenious contributions to modern science. The theory gives a remarkably clear and simple account of the large changes in the osmotic pressures of proteins caused by acids and alkalis. Much work remains to be done to elucidate the smaller effects caused by different salts. Recent experimental observations on hæmoglobin in phosphate buffers show an increase in osmotic pressure in

the more acid and the more alkaline solutions, in general agreement with the theory; but the point for minimum osmotic pressure is on the acid side of the *p*H for minimum combination with acid or base. The difference may be as much as 0·2 *p*H units for 0·01 molar phosphates and 0·7 units for 0·05 molar phosphates.

Measurements of the membrane equilibrium of ions, if allowance is made for hydration of the protein, indicate that hæmoglobin causes relatively small changes in the activities of cations like sodium, potassium or ammonium, and relatively large diminutions in the activity coefficients of phosphate and chloride ions[1].

A reaction of the following type might cause similar changes in ion distribution and osmotic pressure:

$$-Pr^{+} + Na^{+} + Cl^{-} = [PrCl]^{-} + Na^{+},$$

where $-Pr^{+}$ denotes a protein double ion, $[PrCl]^{-}$ a protein ion with a combined or associated chloride ion neutralizing one positive charge. Although salts tend to diminish the osmotic pressure in the range of concentrations studied by Procter and Wilson, they usually increase the pressure in the range where most of the observed pressure is due to the protein itself.

This observation might be explained if groups on the surface of the protein molecule can attract either an inorganic ion or a second protein molecule. If many inorganic ions are present, the chance of attracting a second protein molecule is diminished, and the osmotic pressure should be increased. The effect may be compared with a diminution in the term a in van der Waals' equation for gas pressure. The net excess of salt associated with a protein can be correlated with its solubility and activity.

In studies of the effects of electrolytes on swelling and osmotic pressure of proteins, reproducible results are most readily obtained by the use of relatively large volumes and several changes of the external liquid or dialysate, preferably a buffer mixture with a well-defined *p*H value.

The chemical potentials of salts, acids and water must be the same on both sides of the membrane in a state of equilibrium[2]. Buffer mixtures can be used to control the potentials in a series of protein solutions in a manner comparable with the control of temperature by a thermostat. Thermodynamical formulæ applicable to dialysed protein solutions may be derived from a function Ag, a revised form of the first definition[3] of which is stated as follows: the function Ag, termed the generalized free energy, of any system is equal to the total energy of the system, minus the sum of all individual forms of energy that include an intensive factor controlled by an external system.

The factors here termed intensive are the temperature, T, the pressure with a negative sign, $-P$, $(-P = \delta U/\delta V)$, and the chemical potentials. The total energy of a fluid, U, is regarded as the sum of at least three individual forms of energy, the thermal energy TS, the mechanical energy $-PV$ and the chemical energy $\mu_i n_i$ for substance i; S is entropy of the fluid; V is volume; n_i is number of molecules of i; μ_i is chemical potential of i.

In fluids with a constant mass of each substance, there are two intensive factors to consider, T and $-P$, four combinations of intensive factors, and four possible values for Ag, equivalent to the well-known functions termed energy, heat content, free energy of Helmholtz and free energy of Gibbs. If any of the potentials be controlled, an unlimited number of functions of the same type can be obtained by deducting products like $\mu_i n_i$ from the energy. All the functions are special cases of one function Ag, so that methods used in deriving thermodynamical relationships from the well-known functions[4] may be applied to more complex systems, such as dialysed protein solutions, where potentials are controlled. The formula $\mu_p = \delta Ag/\delta n_p$, for example, is valid for all systems if μ_p represents the potential of a non-diffusible substance, for example, protein. It will be remembered that Henry Procter himself was not entirely satisfied with standard forms of the second law of thermodynamics expressed in terms of entropy. A revised form of the law may be suggested as follows: the generalized free energy of any system tends to reach a minimum.

[1] Adair, G. S., and Adair, M. E., *Biochem. J.*, **28**, 1230 (1934).
[2] Adair, G. S., *Trans. Farad. Soc.*, **31**, 98 (1935); **33**, 1106 (1937).
[3] Adair, G. S., Abstracts of Communications, International Physiological Congress, Oxford, 125 (1947).
[4] Lewis, G. N., and Randall, M., "Thermodynamics" (New York, 1923).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 25

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. Frank Debenham: "The Great Ross Barrier of the Antarctic".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Hill, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "A Western European Power Network?" (to be opened by Mr. T. Graeme N. Haldane).

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 5.30 p.m.—Mr. W. J. Gibbs: "Tensor Analysis Applied to Electrical Machines".* (Further Lectures on November 1, 8, 15, 22 and 29.)

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. F. E. Simon, F.R.S.: "The Unattainability of Absolute Zero".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. E. R. Thornley and Mr. G. A. Pittman: "A Dynamic Compression Test for Rubber/Cord Fabric Adhesion".

Tuesday, October 26

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. B. Fry: "Visible Speech".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Miss P. M. Kaberry: "The Position of Women in a Bamenda Tribe, British Cameroons".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Mr. F. Hoyle: "Stellar Evolution and the Expanding Universe". (Further Lectures on Tuesdays, November 2 and November 9.)

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Cecil Binney: "Legal and Social Implications of Artificial Insemination".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. M. W. Thring: "The Construction of Models in which more than One Process is Similar to the Original".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Measurement of Phase Angle of Electric Circuits" (to be opened by Mr. Arvon Glynne).

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Prof. M. L. Oliphant, F.R.S.: "The Atomic Age—the Scientific Achievement".*

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Dr. H. J. Woods: "The Structure of Fibres".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the WELWYN GARDEN CITY SCIENTISTS' CLUB, at The Cherry Tree, Welwyn Garden City), at 8 p.m.—Dr. T. S. Jones: "Polypeptide Antibiotics—Biological Polymers".

Wednesday, October 27

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Dr. E. J. F. James: "Chemistry and Education".*

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. J. H. Paterson: Presidential Address.

Thursday, October 28

CHADWICK PUBLIC LECTURE (at University College, University Park, Nottingham), at 4 p.m.—Sir Arthur MacNalty, K.C.B.: "Advances in Preventive Medicine during the War of 1939–1945".•

LINNEAN SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5.10 p.m.—Dr. Helga S. Hacker and Dr. P. H. Hacker: "Local Variations and Chances of Interbreeding in *Apodemus sylvaticus*, the Long-tailed Wood-Mouse".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Kenneth Clark: "Three 'Scientific' Painters", 1, Uccello. (Further Lectures on Thursdays, November 4 (Piero della Francesca), and 11 (Seurat).)

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. K. Linderstrøm-Lang: "Micromethods in Biology".•

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. K. de B. Codrington: "The Place of Archæology in Indian Studies".•

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—A member of the staff of Handley Page, Ltd.: "Aircraft Engineering and Production".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in Room B1, The University, St. George's Square, Sheffield), at 6.30 p.m.—Mr. E. C. Fieller: "The Activities of the Mathematics Division of the National Physical Laboratory".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. P. Armitage: "Sequential Methods of Sampling Inspection".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7 p.m.—Sir Robert Robinson, F.R.S.: "Strychnine, Brucine and Vomicine".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. C. H. Hampshire: "The British Pharmacopœia, 1948".

Friday, October 29

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL OF THE PHYSICAL METHODS GROUP (in the Main Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Annual General Meeting; Discussion on "Polarography in Biochemistry".

CHEMICAL SOCIETY, GLASGOW BRANCH (joint meeting with the ANDERSONIAN CHEMICAL SOCIETY and GLASGOW UNIVERSITY ALCHEMISTS' CLUB, at the Royal Technical College, Glasgow), at 3.45 p.m.—Prof. John Read, F.R.S.: "Chemical Personalities of a Century Ago".

ROYAL ASTRONOMICAL SOCIETY (joint meeting with the ASTRONOMICAL SOCIETY OF EDINBURGH, at the Royal Society of Edinburgh, 22–24 George Street, Edinburgh), at 4.45 p.m.—Scientific Papers.

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM BRANCH (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 5 p.m.—Prof. W. Baker, F.R.S.: "Recent Work on Systems of Aromatic Type" (Bedson Club Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. K. Linderstrøm-Lang: "Enzymatic Breakdown of Proteins, I".•

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. S. S. Cook, F.R.S.: "Thermodynamics in the Making" (Andrew Laing Lecture).

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. C. Wainwright: "Statistical Principles in Quality Specifications for Plastics".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (in the Lecture Room of the Society of Architects, 16 St. Mary's Parsonage, Deansgate, Manchester), at 6.45 p.m.—Mr. P. Armitage: "Sequential Methods of Sampling Inspection".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the CAMBRIDGE UNIVERSITY CHEMICAL AND METALLURGICAL SOCIETIES, at the University Chemical Laboratory, Pembroke Street, Cambridge), at 8.30 p.m.—Sir Charles Goodeve, F.R.S.: "The Physical Chemistry in Iron and Steel Processes".

Saturday, October 30

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "Partition Chromatography and its Application to Biochemical Problems".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mr. R. D. Barnett: "Digging up Past Civilisations".•

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY DIRECTOR—The Director, Museum and Art Gallery, Newport, Mon. (October 30).

PRINCIPAL AND A HEAD OF THE AGRICULTURAL DEPARTMENT at Essex Institute of Agriculture, Writtle, Chelmsford—The Chief Education Officer, County Offices, Chelmsford (October 31).

LECTURERS (2) IN HORTICULTURAL SCIENCE—The Principal, East Horticultural Institute, Swanley (November 6).

RESEARCH LECTURER IN THE DEPARTMENT OF COLOUR CHEMISTRY AND DYEING—The Registrar, The University, Leeds 2 (November 8).

PRINCIPAL SCIENTIFIC OFFICER to control research and development of radio and radar navigation devices and aircraft approach and landing aids, a PRINCIPAL SCIENTIFIC OFFICER to control research and development of radio communication systems, airborne and ground; electro-acoustic and sound recording equipment; special test equipment for such devices, a PRINCIPAL SCIENTIFIC OFFICER to control development of general radio test equipment for Service use and special radio and electronic test equipment for test purposes, and a SENIOR SCIENTIFIC OFFICER for the development of components for new radio equipment—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2300 (November 11).

LECTURER IN APPLIED MATHEMATICS—The Registrar, University College, Southampton (November 13).

FARM MANAGER at the Council's Institute of Animal Physiology, near Cambridge—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (November 15).

LECTURER IN PHARMACOLOGY in the Department of Materia Medica, Medical School, Dundee—The Secretary, University of St. Andrews (November 30).

PROFESSOR OF VETERINARY SCIENCE at Makerere College, Kampala, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (November 30).

LECTURER IN THE DEPARTMENT OF PHYSICS at Pietermaritzburg, and a LECTURER IN THE DEPARTMENT OF EXPERIMENTAL PHYSICS, at Durban—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (December 1).

CHAIR OF GEOLOGY—The Registrar, The University, Nottingham (December 31).

ASSISTANT LECTURER AND DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

DIRECTOR OF THE JEREMIAH HORROCKS OBSERVATORY—The Chief Education Officer, Municipal Building, Preston.

ENTOMOLOGIST to the States of Jersey—Dr. T. Small, 14 Esplanade, St. Helier, Jersey, Channel Islands.

LABORATORY TECHNICIAN—The Secretary, University College Hospital, Gower Street, London, W.C.1.

LECTURER IN CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby.

LECTURER IN CHEMISTRY and a LECTURER IN PHYSICS—The Principal, Acton Technical College, High Street, London, W.3.

MATHEMATICIAN to assist in theoretical research on the deformation of metals—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICAL CHEMIST having some research experience in surface chemistry or in methods of examination of fine powders, and a CHEMIST with experience of inorganic analysis—Director of Research, British Whiting Federation, 26 Claremont Road, Surbiton, Surrey.

RESEARCH BIOCHEMIST in the Special Unit for the Study and Treatment of Juvenile Rheumatism—The Administrative Officer, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks.

RESEARCH ENGINEER, PHYSICIST or METALLURGIST to take charge of a Rolling Mill Research Team, and a RESEARCH ENGINEER, PHYSICIST or METALLURGIST to initiate work on Forging, at Sheffield—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

SENIOR GEOLOGIST for Mines Department, Adelaide, to undertake and supervise geological investigations on mineral deposits in South Australia and to advise on geological aspects of exploitation—The Agent General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1.

ASSISTANT EXPERIMENTAL OFFICER (Chemist, male) for the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, London, S.W.7.

PRINCIPAL FOR BURY TECHNICAL COLLEGE—The Director of Education, Education Offices, Bury.

TECHNICIANS (2) (Grade II) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, University College, Gower Street, London, W.C.1, quoting Chemistry 5.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History. Vol. 11, No. 4: A Symposium on Fish Populations, held at the Royal Ontario Museum of Zoology, Toronto, Canada, January 10 and 11, 1947. Pp. iii+283. (New Haven, Conn.: Yale University, 1948.) 4.25 dollars. [287

Bernice P. Bishop Museum. Special Publication 38: Studies in Hawaiian Pollen Statistics, Part 2, The Pollens of the Hawaiian Phanerogams. By Olof H. Selling. Pp. 430+58 plates. (Honolulu: Bernice P. Bishop Museum, 1947.) [38

Annual Report of Ontario Research Foundation, 1947. Pp. 24. (Toronto: Ontario Research Foundation, 1948.) [38

Catalogues

Measuring the Future: Scientific Progress illustrated by the Wartime Experience of Messrs. Baird and Tatlock (London), Ltd. By John Langdon-Davies. Pp. 52. (London: Baird and Tatlock (London), Ltd., 1948.)

Book Bulletin, No. 5. Pp. 16. (Cambridge: Bowes and Bowes, Ltd., 1948.)